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DELAYED EXCRETION IN UROGRAPHY AND ITS SIGNIFICANCE

by

Hans Idbohrn

BOEMINGHAUS (1932) must be credited with our basic knowledge on the delay or absence of excretion of contrast media injected in urography. He found ligation of a ureter in rabbits a few minutes before the intravenous injection of the radiopaque medium delayed excretion from the corresponding kidney and that the contrast medium collected in the parenchyma. After 13 hours contrast medium was no longer demonstrable in the kidney. In a later study on dogs and rabbits he showed that an injection 12 hours after ligation of the ureter was not followed by any excretion or accumulation of the medium in the congested kidney. From observations made in these animal experiments, he laid down certain rules for the interpretation of urograms of patients with acute ureteral obstruction. Thus, rapid filling of the renal pelvis and ureter with contrast medium suggests transient stasis. Accumulation of contrast medium in the parenchyma, but not in the renal pelvis and ureter, indicates several hours' obstruction of the ureter; the longer the obstruction, the longer the renal pelvis and ureter will take to become filled. Finally, slight or practically absent excretion of contrast medium indicates that the ureter has been obstructed for several days.

The importance of urography in the investigation of conditions with acute urinary stasis has been stressed by many workers in this field (*e. g.* HELLSTRÖM 1934, HELLMER 1935, WULFF 1935, 1936 and 1942, ARNESEN 1939). The fundamental roentgenographic signs of an obstructed kidney were set forth by HELLMER (1935), and its clinical significance was demonstrated mainly by WULFF (1935, 1936). Non-excretion of intravenously injected contrast medium is, according to HELLMER (1935), one of the signs of an acute attack of renal or ureteric stone.

Submitted for publication, Jan. 9, 1954.

From the Roentgendiagnostic Departement (Director: Prof. OLLE OLSSON) of the University Clinics of Lund, Sweden.

However, continued examination will often show that after several hours contrast medium appears in the renal pelvis (HELLMER 1935, WULFF 1936, BRAASCH & EMMETT 1936). This now well-known observation was pointed out as late as 1946 by HEILBRUN & CHITTENDEN.

On elimination of the obstruction in acute urinary stasis, the kidney reassumes its function, as shown by the ordinary rate of excretion of intravenously injected contrast medium.

In some cases, however, urinary stasis persists. The obstruction may be due to a stone, to a constricting inflammatory lesion or to a tumour involving the ureter. In these cases the question will arise as to what extent renal function is impaired by the urinary stasis. This point is of essential therapeutic importance. However, in this respect the urographic findings are less informative for the following reasons.

A. It is not possible to date the onset of the obstruction

In acute cases the commencement of the obstruction may be assessed although the onset is often insidious. Another difficulty is that the obstruction is frequently only partial. Obstruction by a ureteric stone may be intermittent or complete obstruction may become partial if the stone is lodged in a bulge of the ureter or if a groove forms in the stone and thereby permits the passage of urine (DOURMASHKIN 1932, WULFF 1936).

Opinions differ as to the importance of the time factor in urinary stasis. KIDD (1920) puts the expectant management of ureteric calculus as up to 2 years provided there are no imperative indications for operative interference. ROWLANDS (1920) states that if a stone cannot be shown to be moving downwards on repeated roentgen examination over some six months, it is wise to remove it in order to restore the kidney to its normal function. GROSSMANN (1929) thinks that no hard and fast rules can be formulated concerning the duration of expectant management because it is not possible to determine with certainty whether the obstruction is complete or partial. If conservative treatment fails to produce satisfactory results within 8 weeks, however, surgical intervention is indicated. MINDER (1935) considers that any ureteric calculus that does not change its position within 6 months represents a serious risk and necessitates continual checking of the renal function. BOEMINGHAUS & ZEISS (1935) and BOEMINGHAUS (1940) considered that the power of regeneration of a damaged kidney cannot be given in a general formula. However, if complete obstruction is of more than 3—4 weeks standing, recovery of satisfactory renal function can, according to these authors, hardly be expected; the occlusion should therefore not be allowed to persist more than 2—3 weeks. HELLSTRÖM (1935) reported 18 cases of ureteric stone in which the calculus passed spontaneously within 3

months to 3 years without permanent changes in the urinary passages or secondary urinary tract infection. In a few of these cases intravenous urography was carried out after the passage of the stone, but in none were the ureters dilated. PILCHER & AIKENHEAD (1940) reported a case of accidental bilateral ligature of the ureters with nephrostomy after 3 and 7 days respectively, after which urography showed no signs of a pathologic condition. LAUBER (1940) described an interesting case with no excretion of the contrast medium during urography due to an occluding ureteric stone. He did not state how long the ureter had been occluded. After operation that kidney produced 4 to 5 times more urine than the healthy kidney, but the specific gravity was low. In this case the function of the kidney was severily impaired and the power of reabsorption in the tubuli was lost. ROLNICK (1949) — without giving any definite reason — writes in the Practice of Urology: "In order to restore renal function and to relieve the ureterectasis and pyelectasis, removal of the obstructing calculus should be carried out after a period of 3 to 4 weeks. However, even after ureteral occlusion of a few months, the kidney will return to normal in many cases when the stone is removed".

In a series of papers HINMAN (1919—1943) discussed the important problem of the restitution of the kidney in hydronephrosis. In hydronephrosis in dogs he found a considerable initial recovery of function and repair hypertrophy of the kidney after relief of up to 28 days' total obstruction. He introduced the term renal counterbalance. By this he meant "the anatomic and functional re-adjustment between the less injured or uninjured portion and the more injured portion in the performance of the total work required".

If one of the kidneys is removed or destroyed by ureteric obstruction, extra work is thrown onto the fellow-kidney, which then becomes hypertrophic. If the obstruction is removed before the parenchyma is destroyed and before the kidney has lost its power of recovery, the urinary excretion is divided between the two kidneys according to certain laws. Injury to a kidney undergoing compensatory hypertrophy is followed by an alteration in the amount of urine excreted by that kidney in relation to the contralateral kidney. Loss of a kidney is followed almost immediately by compensatory increase in the work performed by the fellow-kidney, although more or less complete development of the corresponding anatomic changes may require several weeks. Hydronephrosis of, say, 4 to 6 weeks standing is long enough for the development of complete, compensatory hypertrophy of the fellow-kidney. Once this state is reached, the hypertrophic kidney will continue to perform the major part of the total renal function even after removal of renal obstruction on the other side. This means that the hydronephrotic kidney will be hardly, if at all, stimulated to function. Now, as the power of recovery of a kidney depends on functional stimulation, and as restitution is favoured most by a gradual increase in such stimulation, it may be inferred that the prospects of recovery of a kidney after prolonged hydronephrosis are fairly poor.

From observations made in animal experiments JOELSON et al. (1929) claim to have disproved HINMAN's theory of renal counterbalance. In their experiments, however, the ureter was ligated for only 12 to 19 days,

i. e. too short a period, because atrophy of disuse does not appear until after about 4 weeks' occlusion (HINMAN 1930).

HELLSTRÖM (1942) reported that the power of regeneration of the kidney varies widely from one individual to another; in one patient regeneration may be fairly rapid and renal function improved, while in another atrophy may progress and renal function gradually become worse. This variation may be ascribed to several factors. As already mentioned, it is usually not possible to date the onset of the obstruction with certainty or to decide whether obstruction is complete or partial. This in turn makes it difficult to assess the degree or extent of renal damage. Renal stasis is often associated with infection. Both experimental and clinical evidence has shown that in hydronephrosis the presence of infection favours the destruction of the parenchyma and inhibits regeneration (HINMAN). In many cases the damage to the kidney by infection is of greater importance than the obstruction (ROLNICK 1949). When assessing the power of regeneration of a kidney, the state of the contra-lateral kidney must also be considered.

B. Different anatomic changes are capable of producing essentially one and the same roentgenographic appearance

(a) Excretion may be decreased or absent despite a healthy parenchyma. In his study on dogs and rabbits BOEMINGHAUS (1932) found that the excretion of intravenously injected contrast medium varies with the intrapelvic and the intra-ureteral pressure, increase in the pressure slowing excretion. In investigations of the physiology of the kidneys it has been observed that urinary excretion ceases if the systolic blood-pressure is decreased to about 70 mm Hg., which corresponds to an orthostatic pressure of about 45 mm Hg. in the capillaries. For the kidneys to be able to excrete urine, the excretory pressure must exceed the sum of the colloidal osmotic pressure (about 40 mm Hg.) and the intrapelvic pressure (normally about 5 mm Hg.). The significance of decreased blood pressure in urographic examinations has been shown by WICKBOM (1950). If the blood pressure falls to 70 mm Hg. or below, excretion ceases. When the blood pressure again exceeds this critical value excretion again begins.

(b) In some cases good excretion of the contrast medium is observed despite a poor renal parenchyma. This phenomenon, selective urography, was described by OLLE OLSSON (1943). In the presence of renal tuberculosis or other local destructive lesions, the anatomic changes may for a long time involve only part of the kidney. The excretion of contrast medium from the affected renal parenchyma is impaired with con-

sequent poor concentration of the contrast medium in the urine. The uninvolved portion of the kidney can produce urine with ordinary concentration of the contrast medium. Owing to the motility of the renal pelvis and the high specific gravity of the contrast medium, the entire renal pelvis becomes filled with the latter. In such cases, that part of the renal pelvis lying within the area involved by the destructive process is filled in a retrograde direction. Realisation of this roentgenographic sign is of importance in the evaluation of the extent of certain pathologic processes. The phenomenon explains why contrast filling of the renal pelvis is sometimes good despite extensive destruction of the parenchyma.

(c) Impaired excretion of the contrast medium because of parenchymal destruction.

Appraisal of renal function by excretory urography has proved helpful in the investigation of permanent renal stasis. Experience has shown, for example, that urography is a useful guide in the preoperative assessment of renal function of patients with hypertrophy of the prostate gland (TROELL 1935, LIEDBERG 1941 and others). In the investigation and treatment of chronic urinary stasis, many aspects must be considered. In the planning of therapy of the primary disease, possible involvement of the kidney must be borne in mind. Renal affection may sometimes decide or influence the choice of therapy. For instance, it may be a question of a malignant tumour that might be rendered operable by radiotherapy. But radiotherapy delays surgical intervention, and during such delay the affection of the parenchyma may progress to such an extent as to make recovery of renal function impossible. Undelayed pyelo- or ureterostomy might perhaps save the kidney from total destruction. On the other hand, stasis might lead to complete loss of renal function as early as the time of the first examination, and then pyelostomy or ureterostomy would be purposeless. The following few case reports are given to show that the urograms will often not permit any conclusions about the power of recovery of the kidney after the elimination of stasis.

Case 1. I. K., male, born 1895. Surg. 2465/43, 4310/46.

From 1941 to 1943 the patient had several attacks of pyelitis. Urography in June 1943 revealed a 8 mm × 4 mm stone in the left kidney. In March 1946 he had an attack of pain over the region of the left kidney. Nine days later a roentgenologic examination of the urinary tract revealed large kidneys and a calculus (13 mm × 5 mm) in the middle of the left ureter; urography showed only slight accumulation of contrast medium in the parenchyma of the left kidney and no excretion. On re-examination after a more severe attack of pain 3 months later, it was observed that the calculus had passed down into the lower part of the ureter. Urography was not performed. The calculus was now removed. After the operation there were several periods when fistula formation occurred in the scar. On control urography in October 1946, the left kidney was slightly enlarged and still no excretion of contrast medium was demonstrable. The left ureter was then transplanted into the large bowel (Coffey). The ureter was dilated and full of cloudy fluid.

On further control urography in February 1952, the right kidney was found to have increased in size. The left kidney was smaller than the fellow-kidney and than at the examination in 1946. No calculus was observed. Contrast medium excretion: right kidney normal, left kidney no function.

Comments. It is probable that a calculus had partially or completely obstructed the ureter for some three-and-a-half months before operation. Subsequent recurrent fistula formation in the scar led to the erroneous assumption of recovery of function of the left kidney. Three-and-a-half months later excretion of any contrast medium during urography was still absent. The ureter was transplanted into the large bowel but the loss of renal function was permanent.

Case 2. A. R., male, born 1905. Surg. 226/41, Ort. 662/41. Med. 2612/48.

During prolonged rest in bed because of septic spondylitis, renal calculi were diagnosed in both kidneys in October 1941. The left kidney was definitely smaller than the right. After repeated attacks on both sides, but usually the left, a ureteral calculus measuring 15 mm × 11 mm was demonstrated at the level of the left sacro-iliac joint in December 1942. The left kidney was still smaller than the right. On intravenous urography the left side showed no excretion, nor was any accumulation in the parenchyma observed. Control urography one month later showed the same state. Operation after another week revealed a thick-walled ureter and disintegrating calculi, but no retention of urine behind them. On further urography 2 weeks later a further decrease in the size of the functionless left kidney (from 10.5 cm × 5.5 cm in December 1942 to 8.5 cm × 4.5 cm) was noticed, while the right kidney was unchanged.

Renal function was not studied again until 1950, and then as a routine measure in connection with the investigation of hypertension and cardiac incompensation. The left kidney was small and the right enlarged. No stones were visible. The left kidney still showed no excretion of contrast medium on urography. The cardiac incompensation increased and in March 1951, the patient died.

Post-mortem examination: The left kidney was small (35 g) and lobulated, its surface granular and the parenchyma had undergone atrophy. The renal pelvis was dilated. The ureter was not obstructed, but along 5 cm of its length it was adherent to the pelvic wall. The right kidney showed compensatory hypertrophy (250 g). Pathologist's report: Left-sided secondary contracted kidney due to pyelonephritis with hydronephrosis.

Comments. There was reason to assume that the left ureter was occluded for at least 5 to 6 weeks. The calculus might have been lodged in the ureter still longer, because throughout 1942 the patient had recurrent attacks at short intervals. On post-mortem examination 8 years later the left kidney was markedly decreased in size and showed pyelonephritic changes, the right kidney being compensatorily enlarged. The loss of function of the left kidney observed on urography was obviously due not to stasis, but to parenchymal destruction. In this case, the patient should have been subjected to nephrectomy rather than uretherolithotomy.

Case 3. J. B., male, born 1877. Surg. 2839/45, 4894/46, 3269/47.

In April 1945, the patient had acute hematuria. Cystoscopy showed contracture of the bladder with cancriform changes at the left ureteral orifice. Pathologist's report: Lesion strongly suggestive of cancer. Urography in May 1945, showed no signs of a pathologic condition of the kidneys, but a tumour in the left posterior part of the bladder.

Operation July 1945 (after preoperative roentgen therapy): Extirpation, electrocoagulation and implantation of radium needles. Pathologist's report: Urinary bladder cancer. Urography, January 1946: The kidneys were normal in size. Contrast medium excretion: normal. Cystoscopy, May 1946: Recurrence. Urography, August 1946: No

definite change in size of the left kidney was discernible. The right kidney had increased slightly in breadth; the rate of excretion of the contrast medium was normal; the renal pelvis and the ureter were slightly dilated. No excretion from the left kidney; no accumulation of contrast medium in the parenchyma. Operation, August 1946: Transplantation of the right ureter into the large bowel (Coffey); the right ureter was thin-walled and slightly dilated. Urography, September 1946: Still no excretion from the left kidney.

Operation, October 1946: Transplantation of the left ureter into the large bowel (Coffey); the left ureter was the thickness of a small finger. No information was available about any urinary retention.

Urography, November 1946: The right kidney had decreased somewhat in size and the renal pelvis and the ureter were no longer dilated; left kidney was still functionless.

Urography, January 1947: The left kidney was diminished (11 cm × 5.5 cm), the right unchanged in size; excretion as before. Operation, January 1947: Extirpation of the bladder; the tumour had grown far out into the perivesicular tissue.

Urography, July 1947: the left kidney had diminished slightly in size. Loss of renal function was permanent. In September 1947 the patient died from cancer with skeletal metastases.

Comments. It cannot be assessed with any degree of certainty how long the bladder cancer had occluded the left ureteral orifice. Cystoscopy in May 1946 revealed a recurrence and in August that year excretion from the left kidney was not demonstrable. Operation was not performed until after the lapse of a further 2 months. Loss of renal function on that side proved permanent and ureteric transplantation was thus purposeless.

Case 4. N. L., male, born 1877. Surg. 4589/46, 2967/47, 985/49.

Since the end of 1945 the patient had bladder symptoms with hematuria and loss of weight. In July 1946 a tumour was diagnosed near the right ureteric orifice. Urography in July showed complete lack of excretion from the right kidney and cystography in August revealed the right half of the bladder to be occupied by a large, irregularly outlined tumour. After roentgen therapy the tumour diminished considerably, but urography in October showed persistent absence of excretion. The kidneys then appeared to be of normal size. On cystoscopy in October, the right ureteral orifice and the right part of the trigonum were covered by a gross lobulated tumour. 3 days later the patient was submitted to palliative extirpation and the implantation of radium needles. Pathologist's report: Malignant papilloma of the bladder. In May 1947 the right kidney still showed no evidence of excretion and in July a recurrence was observed at the right ureteric orifice. Urography, July: The right kidney had diminished in length; there were still no signs of excretion. Operation: Both ureters were transplanted into the large bowel (Coffey); the left ureter was of normal width, the right was the thickness of a small finger and not particularly thin-walled. The contents were cloudy. Despite this intervention, urography in August 1947 showed that the right kidney had not recovered functional activity; it seemed to be enlarged. The left kidney was slightly enlarged as compared with the earlier examinations and the renal pelvis and the ureter were somewhat dilated. In February 1949 a marked decrease in body weight was noted and examinations revealed a small recurrence in the bladder and increased NPN.

Comments. It is not known how long the right ureteral orifice had been occluded by the tumour. The bladder symptoms started in December 1945 and the initial urographic examination in July 1946 showed that the right kidney was no longer functioning. As the tumour was situated immediately adjacent to the right ureteric orifice, it may be assumed that it occluded the orifice early. Loss of renal function was perhaps

permanent as early as July 1946. Ureterostomy which was not performed until 1 year later, was not followed by recovery of renal function and was, therefore, purposeless.

These cases exemplify a not uncommon situation. The urographic examination will show whether excretion is impaired or not, but it does not offer information as to whether any such impairment is due to increased intrapelvic or intra-ureteral pressure or whether the parenchyma is more or less destroyed. In other words it does not show if the impairment is permanent or temporary. Operation is therefore decided upon in order to save any functional parenchyma, no other renal test being available. The evaluation should be based on the amount of surviving parenchyma and its power to recover its function after removal of the calculus or other obstacle. The present diagnostic procedure entailing expectant treatment is less satisfactory. In addition, it should be borne in mind that expectant treatment involves appreciable risks, particularly of parenchymal destruction.

A more informative method is thus required. With this in mind, it was thought that roentgenographic study of the flow of blood to the kidney might be useful. If the supply of blood to the kidney is impaired, its function must also be impaired, or, as Doss (1946, 1947) puts it, "a kidney is no better than its arterial supply". Renal angiography should therefore provide a method of judging renal function. In other words, renal angiography should help to fill the gap in the information available from urography in cases of delayed or absent renal excretion of an intravenously injected contrast medium. After the introduction of lumbar aortography by Dos Santos in 1929, (1931), much interest has been focused on this type of examination in the study of renal diseases. An investigation of the arterial supply to the kidney by means of renal angiography and the value of this method for appraising renal function will be the subject of a separate article in this journal.

SUMMARY

The difficulty of judging renal function by the urographic appearance of the kidney in delayed or absent excretion of contrast medium is stressed and exemplified by a few clinical cases. The need of a diagnostic method — renal angiography — for supplementing the information available from a urographic examination is pointed out.

ZUSAMMENFASSUNG

Auf die Schwierigkeit, mit Hilfe der Urographie die Nierenfunktion bei verspäteter oder aufgehobener Kontrastausscheidung zu beurteilen, wird hingewiesen. Einige klinische Fälle veranschaulichen diese Tatsache. Die Notwendigkeit einer diagnostischen Methode — der renalen Angiographie — zur Komplettierung der Urographie wird hervorgehoben.

RÉSUMÉ

L'auteur insiste sur la difficulté de juger la fonction rénale d'après les images rénales urographiques dans les cas où l'excrétion du produit de contraste est retardée ou absente, et en donne comme exemples quelques cas cliniques. Il souligne la nécessité d'une méthode de diagnostic — l'angiographie rénale — pour compléter les renseignements fournis par un examen urographique.

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CHOLEGRAPHY IN CHILDREN[1]

by

Georg Theander

In the literature dealing with cholecystography only scanty information can be found on attempts to visualize the gallbladder in children, and the results reported are not very satisfactory. Thus, in his text-book of pediatric roentgen diagnosis, CAFFEY (1950) states that in his practice satisfactory gallbladder shadows had not been demonstrable in children under the age of 3 years. The reports by BOYDEN and FULLER (1934) on a cholecystographic study of the anatomy and physiology of the gallbladder in children are based on a material consisting of subjects between 6 and 11 years of age, and the authors make no reference to the incidence of visualization of the gallbladder. Even CAMPAGNONI (1949) in his study of cholecystography in infants gives only vague information. Describing his method — intravenous injection of tetraiodophenolphthalein in a dose of 5 mg/kg body weight — he points out its difficulties, but no account is given of the number and age of his patients or of the percentage of cases in which contrast filling of the gallbladder was obtained.

Using Priodax (Biliselectan), HRDLICKA, WATKINS and ROBB (1945) carried out a study on 47 unselected infants and children, giving 0.5—1.5 g/10 kg body weight of the contrast medium in repeated doses. Their results are summarized in table 1.

Thus, although the authors consider Priodax to be a satisfactory contrast medium for infants and children over 9 months of age, it may be stated that the procedure used is beset with a considerable number

[1] Cholegraphy refers to the examination which may include both the gallbladder and the bile ducts in contra-distinction to cholecystography which is the term used for the examination usually employed for the representation of the gallbladder, and to cholangiography, exclusively of the bile ducts. (Ed.)

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Table 1

Age	Number of patients	Visualization of gallbladder	
		Successful	Unsuccessful
< 6 months	6	0	6
6—12 »	4	2	2
12—18 »	4	3	1
18—24 »	5	3	2
2—4 years	8	4	4
4—11 »	16	15	1
(5—8 years, with acute catarrhal jaundice)	4	3	1

of failures, and in infants younger than 6 months must be regarded as being unsuccessful.

Now, after the introduction of Biligrafin, it seems possible that visualization of the gallbladder may be attained more often than formerly. It has been stated by FROMMHOLD (1953) that it may be possible to obtain filling of the gallbladder with Biligrafin in cases in which a previous attempt with Biliselectan has failed. Thus, in this respect the new intravenous contrast medium is sometimes superior to the ordinary peroral substances. As regards infants, it is to be expected that Biligrafin may be used for cholecystography even at a very early age.

Material

In 11 children, 12 days to 2 years old, in hospital, cholegraphy was performed, the contrast medium being administered intravenously in a single dose varying from 0.1 to 0.3 g/kg body weight. Two of the children were apparently healthy. One had retrolental fibroplasia, and seven were mongolian idiots with assumed cardiac malformations but were otherwise healthy. In the eleventh case atresia of the biliary passages was assumed and cholegraphy was performed three times, the total dose being 0.4 g/kg body weight.

Results

The results are given in table 2.

Thus, in 9 cases out of 10, in which the liver, gallbladder and bile ducts might be considered normal, cholegraphy with Biligrafin led to visualization of the gallbladder 1 to 17 hours after the injection of the contrast medium. In one of these cases even the common bile duct and hepatic radicles were clearly seen, and the contrast medium appeared in the renal pelves (Fig. 1). In several cases the contrast medium was visible in the bowel 1 to 17 hours after the injection.

Table 2

Case No.	Sex	Age	Dose in g/kg body weight	Interval between injection and appearance of contrast medium in		Contrast medium in bowels	Diagnosis
				bile ducts	gallbladder		
1	♀	12 d	0.1	—	17 h	+	Mongolism
2	♀	7 w	0.2	—	1 h	+	Mongolism
3	♀	10 w	0.1	—	1½ h	+	Mongolism
4	♀	11 w	0.1	—	1½ h	+	Mongolism
5	♀	5 m	0.1	—	4 h		Mongolism
6	♀	6 m	0.15	—	—	+	Mongolism
7	♂	6 m	0.3	4 h	4 h	+	Mongolism
8	♂	9 m	0.1	—	4 h	+	Healthy
9	♂	2 y	0.1	—	1 h		Healthy
10	♀	2 y	0.1	—	1 h		Retrolent. fibropl.
11	♂	10 w	0.4	—	—	—	Atresia of bile ducts

In Case 11, in which atresia of the biliary passages was presumed, no contrast medium could be demonstrated in the gallbladder or bile ducts, or in the bowel or renal pelves. Three weeks after the examination an operation was performed (WULFF) and revealed atresia of the main hepatic duct and its radicles. A gallbladder with liquid contents and an apparently normal common bile duct were present.

No toxic reactions were seen during or after the examinations. About one month after cholegraphy two of the mongolian idiots who had succumbed to a nosocomial respiratory infection, were subjected to post-mortem examination (WINBLAD). The liver showed no histologic changes attributable to Biligrafin.

It appears from these cases that, in infants and children, Biligrafin is superior to the cholecystographic contrast media previously used. In 9 out of 10 'normal' children 12 days to 2 years of age, the gallbladder was visualized; and in the case of non-visualization the contrast medium appeared in the bowel, thus indicating normal passage through the biliary ducts.

It has been shown by LANGECKER, HARWART and JUNKMANN (1953) in experiments in dogs, that after ligation of the common bile duct only exceedingly small amounts of Biligrafin can reach the bowel; even after removal of the kidneys only 0.5 per cent of the dose was chemically demonstrable in the bowel 8 hours after its intravenous injection.

It might be expected that a cholegraphic examination, revealing contrast medium in the bowel, would exclude the presence of atresia of the bile ducts in cases in which this malformation would otherwise have been erroneously diagnosed.

Discussion

The cases reported afford an opportunity for observations which may be of interest regarding the use of cholegraphy as a test for liver function.

Introducing the new contrast medium FROMMHOLD (1953) states that in man as well as in the rabbit 10 per cent of the Biligrafin injected is normally excreted by the kidneys. In disturbances of the hepatobiliary system this renal part of the contrast medium elimination is considerably increased, as determined by chemical analysis of the urine. Studying cholegraphy in cases of liver damage, GAEBEL and TESCHENDORF (1953)

a. b.

Fig. 1. Case No. 7. ♂. 6 months. a. 5 minutes after injection of Biligrafin. Visualization of renal pelves. b. 4 hours after injection. Visualization of gallbladder, common bile duct and hepatic radicles.

observed that the contrast medium in liver insufficiency did not appear in the bile ducts, but in the renal pelves. Moreover, the contrast medium was seen in the renal pelves 10 minutes after the injection, that is in the same time as it would normally appear in the bile ducts. It seems that the authors consider this phenomenon a roentgenographic manifestation of pathologically increased renal elimination of Biligrafin, and considering their cases most impressive, feel that Biligrafin may be used as a test for liver function.

To this it must be objected that visibility of the contrast medium in the renal pelves and in the bile ducts, must be influenced by any variations in diuresis and choleresis. It might happen that a definitely pathologic amount of Biligrafin injected be excreted by the kidneys, but in

such low concentration as not to be visualized roentgenographically — on the other hand it might happen that the normal amount of 10 per cent of the contrast medium be apparent in the renal pelves owing to unusually high concentration.

From this point of view it should be noted that no contrast medium could be recognized in the roentgen films — not even in the renal pelves — in Case 11, where the hepatic ducts were atretic and in which the Biligrafin must be supposed to have been eliminated entirely by the kidneys. On the other hand, in Case 7, which was normal, there was obvious contrast filling of the renal pelves during the first 30 minutes after the injection (Fig. 1a); no contrast was seen in the bile system at that time, but after another $3^1/_2$ hours a good representation of gallbladder and bile ducts appeared (Fig. 1b). Thus it might happen that the maximum concentration of the contrast medium be reached first in one of the excretory organs, and then — after several hours — in the other. As a matter of fact, there can be no justification in drawing any conclusions regarding the prevalence of either manner of elimination from the bare fact that the renal pelves or bile ducts are roentgenographically more or less clearly visualized.

ADDENDUM

After the submission of this paper for publication a report of cholecystography in infants by HARRIS and CAFFEY (J. A. M. A. 153 (1953), 1333) became available. In this series, 27 cholecystographic examinations of 25 patients under 3 years of age were performed with 15 successful visualizations of the gallbladder. Among 12 infants under 6 months of age given Priodax or Telepaque, visualization was successful in 6.

SUMMARY

A report is given of 10 normal cases and one case of atresia of the biliary ducts, in which cholegraphy with Biligrafin was performed, the patients being 12 days to 2 years of age. Nine of the normal cases showed contrast filling of the gallbladder. In the case of non-visualization of the gallbladder, the contrast medium was demonstrated in the bowel. One of the normal cases, at first showing contrast medium in the renal pelves, had filling of the bile ducts 4 hours after the injection of Biligrafin. In the case of atresia of the bile ducts the contrast medium could not be roentgenographically demonstrated in any situation.

The demonstration of Biligrafin in the bowel may be of value to exclude atresia of the bile ducts in cases in which this condition would otherwise have been erroneously diagnosed.

ZUSAMMENFASSUNG

In 10 normalen Fällen und in einem Fall von Atresie der Gallenwege, 12 Tage bis 2 Jahre alt, ist Cholegraphie mit Biligrafin vorgenommen worden. In 9 von den normalen Fällen wurde die Gallenblase sichtbar. In dem Fall, in welchem keine Kontrastfüllung der Gallenblase zu Stande kam, konnte das Kontrastmittel im Darm nachgewiesen werden. Einer der normalen Fälle gab, nachdem er zuerst eine Kontrastausscheidung in den Nierenbecken gezeigt hatte, 4 Stunden nach der Kontrastmittelinjektion sogar eine Darstellung der Gallenwege. In dem Fall von Atresie der Gallenwege konnte nirgends Kontrastmittel röntgenologisch nachgewiesen werden. Es ist hervorgehoben, dass der Nachweis von Biligrafin im Darm ein besonderes Wert dadurch haben möchte, dass eine falsche Diagnose von Atresie der Gallenwege in dieser Weise abgelehnt werden könnte.

RÉSUMÉ

L'auteur présente 10 cas normaux et un cas d'atrésie des voies biliaires, où une radiographie des voies biliaires avec Biligrafin a été pratiquée, les sujets étant âgés de 12 jours à 2 ans. La vésicule biliaire était opacifiée dans 9 des 10 cas normaux. Dans le cas où la vésicule biliaire est restée invisible, le produit de contraste fut mis en évidence dans l'intestin. Un des cas normaux ayant d'abord présenté du produit de contraste dans les bassinets rénaux, eut une opacification des voies biliaires 4 heures après l'injection de Biligrafin. Dans le cas d'atrésie des voies biliaires on n'a pu mettre en évidence radiographiquement nulle part le produit de contraste.

La mise en évidence de Biligrafin dans l'intestin peut être intéressante pour exclure une atrésie des voies biliaires dans des cas où, sans cela, on aurait porté à tort ce diagnostic.

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CYST RUPTURE IN 6 CASES OF POLYCYSTIC RENAL DISEASE

by

Sven Ydén

It is well known that in polycystic renal disease in the adult one of the most common symptoms is haematuria, which frequently forces the patient to seek medical advice. The haematuria may be slight or marked, but is usually intermittent, of varying duration, sometimes painless and occasionally associated with severe colic. That the haematuria may be due to intracystic haemorrhage and rupture of the wall into a calyx or the pelvis has been reported by authors including BRAACH & SCHACHT, LOWSLEY & KIRWIN, SHANKS & JOHNSTONE, WESSON, BUNTSAND & AUSTIN DODSON. However, according to the following statement by WESSON, it would appear that this view is not accepted generally: "It has been repeatedly stated that these cysts never rupture into the pelvis, but they do occasionally, both spontaneously and post-traumatically." Two illustrations are given. As knowledge of the possibility of a cyst rupture as the cause of both slight and marked haematuria is of help in the differential diagnosis, particularly in early cases of polycystic kidney, a brief report on six cases may be warranted.

My Own Series. A recent case (Case 1) of gross haematuria resulting from a ruptured cyst, led me to go through the whole material of polycystic kidney disease examined at the Roentgen Diagnostic Department of Karolinska Sjukhuset. Those cases in which the excretion of contrast medium was not sufficiently good to allow evaluation of details have not been included. In the 26 cases still having satisfactory renal function there were 5 with direct, and 1 with indirect signs of a ruptured cyst.

Case 1: Ur. anomali 939. Male, born 1915. In January 1952 bilateral polycystic renal disease was diagnosed on urographic examination; the patient had had symptoms

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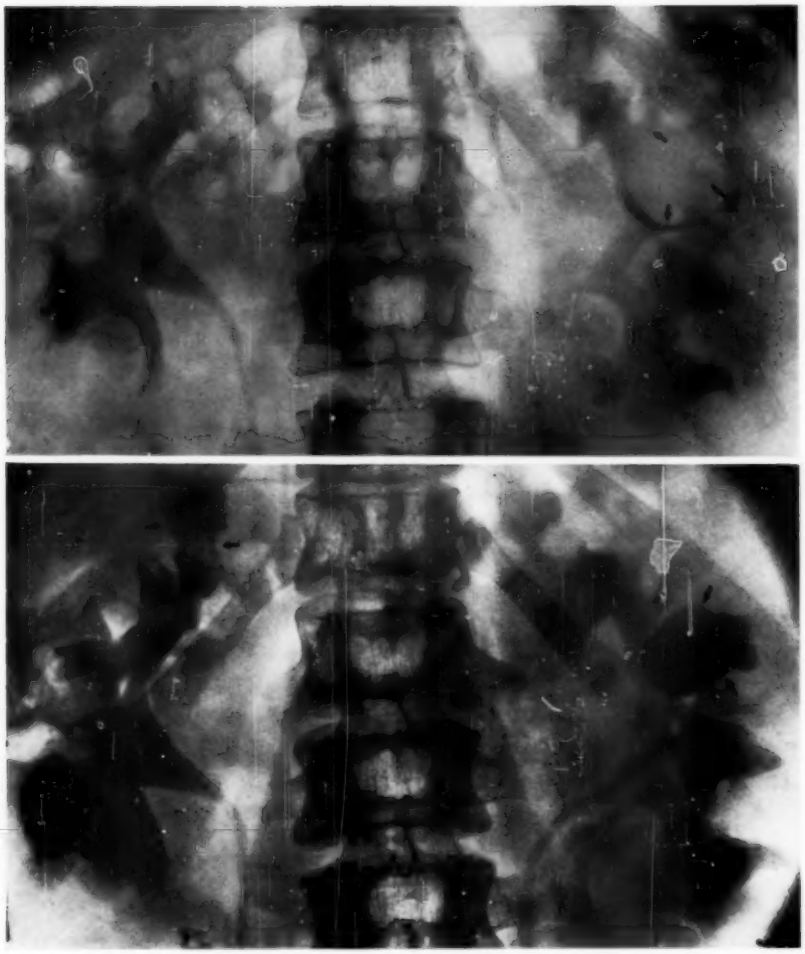
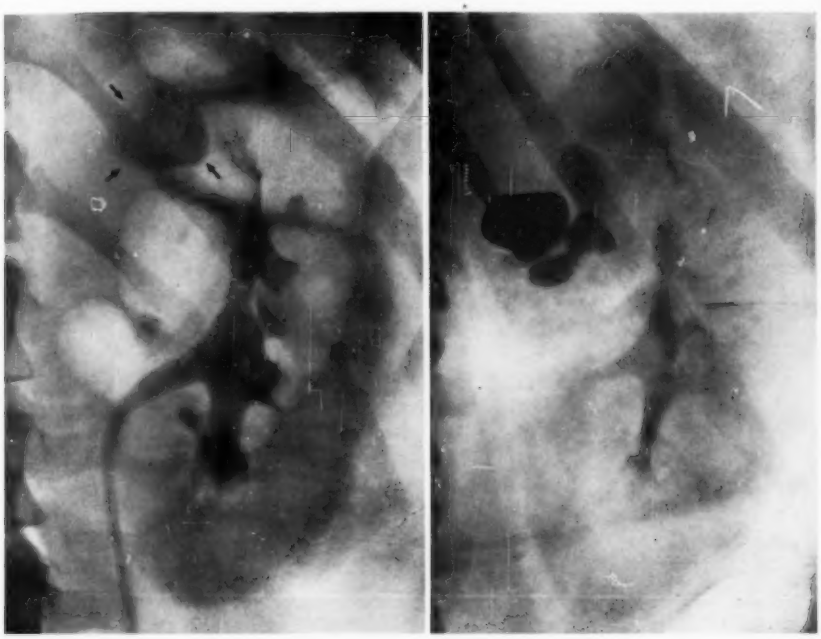


a.

b.

Fig. 1. Case 1. Polycystic kidneys (a) before, and (b) after rupture of the cyst cavity in the upper pole of each kidney.

of discomfort in the region of the left kidney and haematuria had been detected microscopically. At the beginning of September 1953 sudden severe pain, of a non-radiating character, developed in the left lumbar region. Clinically, the attack resembled that associated with a renal calculus. At the same time there was slight pain in the region of the right kidney. After two or three hours, when the pain had begun to subside, there was a copious amount of blood in the urine. The haematuria ceased after 3 weeks. Urography, some 3 weeks after the attack of pain showed that a cyst the size of a walnut,



a. b.

Fig. 2. Case 2. (a) Moderate polycystic kidney with a ruptured cyst in the upper pole. (b) Four small cysts filled with contrast medium by percutaneous puncture are situated below and medially to the spontaneously ruptured cyst.

situated close to the left renal pelvis, had ruptured and been filled with contrast medium in a retrograde direction. Further, in the upper pole of the right kidney a cyst some 3 cm long and 1—1.5 cm wide, communicating with the upper calyx, had been filled with contrast medium. There were crescentic impressions from without into the wall of the cyst (Figures 1 a—b). On further urographic examination a month later the communication between the cyst and the pelvis in the left kidney was seen to be still open. The cyst in the upper pole of the right kidney was not filled with contrast medium.

Case 2: Ur. s. 614. Female, born 1923. The patient had previously been in good health. In february 1951 she had an acute attack of severe pain in the left lumbar region. There was gross haematuria. The clinical tentative diagnosis was renal calculus. Urography at another hospital showed both kidneys to be enlarged, particularly the left which was also seen to have somewhat irregular contours. The left renal pelvis and calyces showed deformation of the type found in polycystic kidney disease. There was no deformation on the right side. An increased space between the medial portion of the left kidney and the spine was, however, considered to indicate further examination, as an expansive process of some other nature could not be ruled out. Cystoscopy showed haemorrhage from the left ureter. On further urographic examination a cyst,

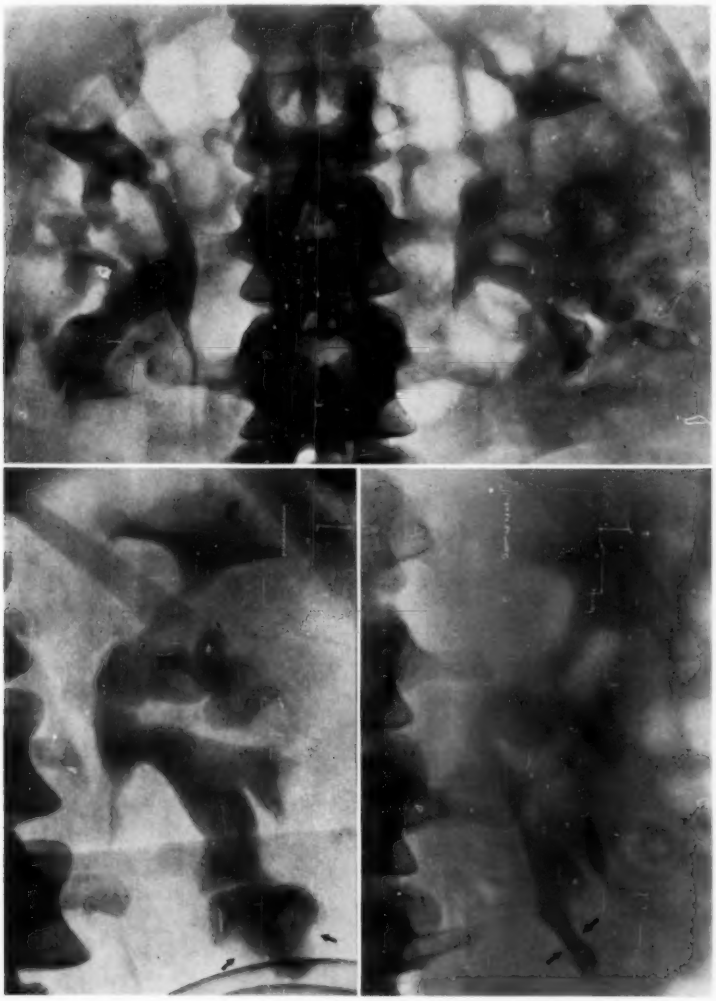
Fig. 3. Case 3. Polycystic kidney; cyst cavity in the right kidney filled with contrast medium.

communicating with an upper calyx, situated medially in the upper pole of the left kidney, was filled with contrast medium (Fig. 2 a). Percutaneous puncture of the upper medial portion of the expansive focus disclosed the presence of several cysts of sizes ranging up to that of a hazel-nut; these did not communicate with each other or with the pelvis (Fig. 2 b). In two of these cysts the content was admixed with blood.

Case 3: Ur. s. 346. Male, born 1886. Urography was motivated by silent haematuria and symptoms of hypertrophy of the prostate gland. This examination disclosed bilateral polycystic kidney disease. Laterally in the central portion of the right kidney a cavity the size of a hazel-nut was filled with contrast medium, the cavity communicating with a calyx (Fig. 3). It was definitely a ruptured cyst.

Case 4: Ur. s. 77. Female, born 1906. The patient had been treated for polycystic kidney disease on several occasions at another hospital. She had had haematuria periodically without any attacks of pain. On urography in April 1946 a cyst in the lower pole of the left kidney, communicating with a calyx, was filled with contrast medium. In earlier urographic examinations this cyst had not been seen to communicate with the calyx. There were crescentic impressions in the walls of the ruptured cyst made by small cysts nearby (Fig. 4 b). $2^1/_2$ years later the appearances had changed. The ruptured cyst was still seen to have open communication with the calyx, but the progressive expansion of adjacent cysts had deformed it to a narrow, oval cavity (Fig. 4 c).

Case 5: Ur. s. 881. Male, born 1913. On the mother's side of his family there were several cases of polycystic renal disease. Since 1939, when polycystic kidney was diagnosed, he had on 4 different occasions had attacks of pain in the region of both kidneys. On 3 of these occasions the pain reached its peak after 2—4 days and then subsided suddenly. The urine, which before the attacks of pain had been clear, became turbid and at the same time, or a day or so later, more or less discoloured by blood.



a.

b.

c.

Fig. 4. Case 4. Serial films taken during a period of 7 years showing progressive polycystic disease. (b) $4\frac{1}{2}$ years after (a) — a cyst cavity filled with contrast medium. Small cysts nearby make crescentic impressions in the outlined cyst which, (c) $2\frac{1}{2}$ years later has been deformed to a narrow, oval cavity in direct communication with the calyx.

a. b.

Fig. 5. Case 5. The rather large cyst seen in (a), medially near the renal pelvis has, (b) $2\frac{1}{4}$ years later, disappeared. On the other hand, other cysts have increased appreciably in size.

Fig. 6. Case 6. On retrograde pyelography of the upper pelvis of the left kidney a cyst cavity was outlined (urography showed bilateral changes typical of polycystic disease).

It would appear that on these occasions cysts had ruptured into the pelvis and the cyst content and blood mixed with the urine. Haematuria ceased after a few days, except after the last attack when it did not disappear until 5 weeks later. No contrast-filling of a ruptured cyst cavity was seen in the radiologic examinations. A comparison of the radiograms of the right renal pelvis made in 1949 and 1953 showed indirect signs of a relatively large cyst, medial to the pelvis, having disappeared; it had probably ruptured (Figs. 5 a—b). Therapeutic percutaneous puncture in 1953 disclosed no cyst in this portion of the kidney.

Case 6: Uro. s. 124 and Pyel. s. 54. Male, born 1903. Urography was carried out in 1944 after repeated attacks of pain in the region of the kidneys during the previous $1^1/_2$ years, lasting for 1—2 days and followed by haematuria; the examination revealed the presence of bilateral polycystic kidneys. On retrograde pyelography of left upper renal pelvis, a rounded cavity with a diameter of 2—3 cm in the medial portion of the upper pole of the kidney was filled with contrast medium (Fig. 6). In all probability it was a cyst which had ruptured into the renal pelvis.

Discussion

As illustrated by these cases of polycystic renal disease, spontaneous rupture of a cyst is no rare phenomenon; sometimes it may be painless and in other cases associated with attacks of intense pain in the region of the kidney and varying degrees of haematuria, as in Cases 1, 2, 5 and 6. The sudden, sharp colic in these four cases may have been due to over-distention by haemorrhage into the lumen followed by rupture of the cyst connecting it with the pelvis. In the symptom complex of polycystic renal disease there are frequently attacks of renal pain without concomitant haematuria. This is probably caused by a rapid rise in pressure in a cyst. Secondarily this leads to distention of the renal capsule which is very sensitive. According to LINDBLOM, the same sensation of pain occurs if the pressure in a cyst is increased by percutaneous renal puncture. He has also found the pressure in the cysts in polycystic kidneys to be appreciably higher than in solitary cysts. The cyst content is not infrequently discoloured by recent or old haemorrhage. If haemorrhage occurs in a cyst which has no possibility of expanding or rupturing into a calyx or the pelvis, it is probable that a relatively slight increase of the cyst content raises the pressure to a level higher than that in the artery, and the haemorrhage ceases.

In Cases 3 and 4 the rupture was not associated with pain. No exact date could be fixed for the rupture from the histories. It is probable that in these cases the mechanism was different. Theoretically it is possible that a symptomless rupture may occur as a result of progressive pressure atrophy of the dividing wall between the renal pelvis and an adjacent cyst which gradually increases in size. The symptomatology of Case 5 is of particular interest. One could, without an urologic examination, assume that a cyst had ruptured into the pelvis. Immediately

after an attack of pain the urine, which previously had been completely clear, was admixed with a turbid fluid, in all probability the contents of a cyst.

The incidence of ruptured cysts in polycystic renal disease is probably higher than is indicated by routine urography. If, for instance, the ruptured cyst cavity is situated ventrally, as in Case 2, either extremely good contrast-filling of the pelvis, or a projection in a prone position, is necessary to demonstrate contrast-filling of the cyst cavity; this did not occur in Case 2 on urography 7 days after the rupture. Further, urography must be carried out within a limited period after rupture of the cyst has occurred if the cavity is to be demonstrated; this is illustrated by Case 4.

In relatively early cases of polycystic kidney with predominantly unilateral changes, the differential diagnosis from solitary cysts and neoplasm may present great difficulty both clinically and radiologically. In these cases it may be of value to know that it is possible to visualise ruptured cyst cavities by urography, if the technique employed is good. One should, of course, bear in mind the possible combination of neoplasm and polycystic disease, but according to MELICOW & GILE, and JOHNSON, this occurs but very rarely. JOHNSON who, himself, described a case, found only 8 cases of this type in the literature.

SUMMARY

Six cases of spontaneous rupture of a cyst in polycystic disease are described. In one of the cases there were indirect signs of cyst rupture, in all the others the ruptured cyst cavity was filled with contrast medium on urography or retrograde pyelography. Two of the cases in the latter group were examined radiologically both before and after the probable date of rupture.

ZUSAMMENFASSUNG

Sechs Fälle mit Spontanruptur einer Zyste bei polyzystischer Erkrankung werden beschrieben. In einem dieser Fälle traten indirekte Symptome einer Zystenruptur auf, bei allen anderen wurde der rupturierte zystische Hohlraum bei der Urographie oder bei der Pyelographie mit Kontrastflüssigkeit gefüllt. Zwei Fälle der letzteren Gruppe wurden sowohl vor wie nach dem wahrscheinlichen Zeitpunkt der Ruptur röntgenologisch untersucht.

RÉSUMÉ

L'auteur rapporte six cas de rupture spontanée d'un kyste dans une maladie polykystique. Dans l'un de ces cas il y avait des signes indirects de rupture du kyste; dans tous les autres, la cavité du kyste rompu se remplissait de produit de contraste par urographie et par pyélographie rétrograde. Deux des cas de ce dernier groupe ont été examinés radiologiquement avant et après la date probable de la rupture.

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ACCESSORY VESSELS OF THE KIDNEY AND THEIR DIAGNOSIS IN HYDRONEPHROSIS

by

Gunnar Edsman

Accessory vessels of the kidney occur rather frequently. In the anatomic literature they are said to be present in about 25 per cent of subjects. Many authors express a difference of opinion as to which vessels should be termed accessory. Most, however, agree in regarding the following kidney vessels as such: those supernumerary branches arising from the aorta and reaching the upper or lower pole of the kidney, vessels originating from the renal artery and running to the kidney poles and those vessels arising from the aorta or the iliac artery distal to the renal artery and supplying the kidney.

In order to obtain an idea of the ratio between the presence of accessory vessels and hydronephrosis, the supply of vessels to the kidneys were studied in 200 cases of renal arteriography performed by direct puncture of the abdominal aorta. Only those arteries were examined and those accessory vessels included which ran in such a way that they might possibly have caused hydronephrosis. The accessory vessels to the upper pole of the kidney were consequently excluded. The hydronephroses in this material have all been associated with obstruction at the level of the uretero-pelvic junction, that is to say, the renal pelvis was dilated but the ureter of normal width.

The present material consists of 388 kidneys with normal supply of vessels in 325. Vessels which branch uniformly in the renal hilum have been regarded as normal. Eighteen kidneys in this group had double renal arteries (Fig. 1) and one kidney three arteries; these arose at about the same level from the aorta and branched regularly in the renal hilum.

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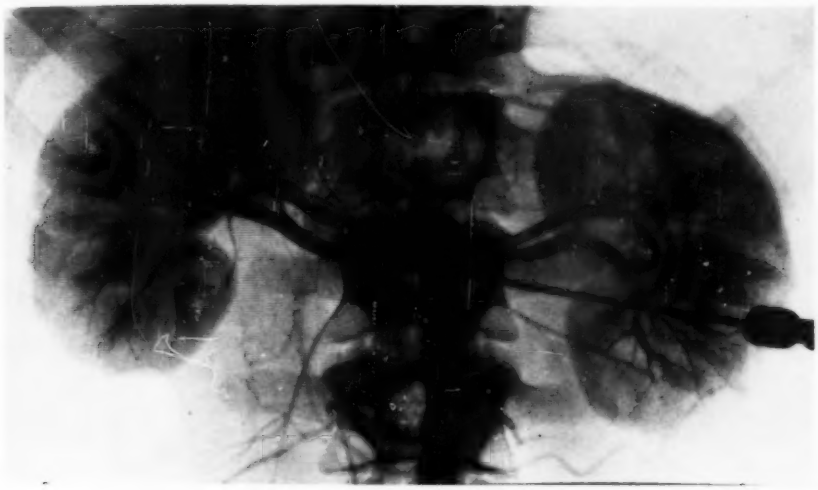


Fig. 1. Double renal arteries on both sides.

The group of accessory vessels from the renal artery includes 4 kidneys. This group is not sharply demarcated from the normal group of vessels and there are several border-line cases owing to the large anatomic variations in the branching of the renal vessel. Only those vessels which showed definite deviation from the other vessels in their course to the lower renal pole, have been classed as accessory.

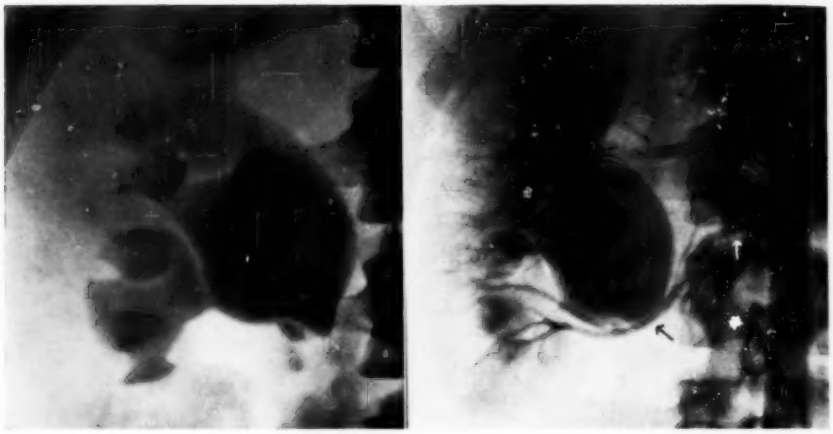
The group of accessory vessels from the aorta includes 59 kidneys where the accessory vessels amounted to one or more, arose from different parts of the aorta and ran to the lower part of the kidney. Accessory vessels were thus found in 16.2 % in the present material.

Based on anatomic studies HELLSTRÖM found 22 % accessory vessels in a material of 50 and EISENDRAHT 15.1 % in a material of 218 kidneys.

The dividing up of the hydronephroses on the basis of the different groups of vessels is as follows:

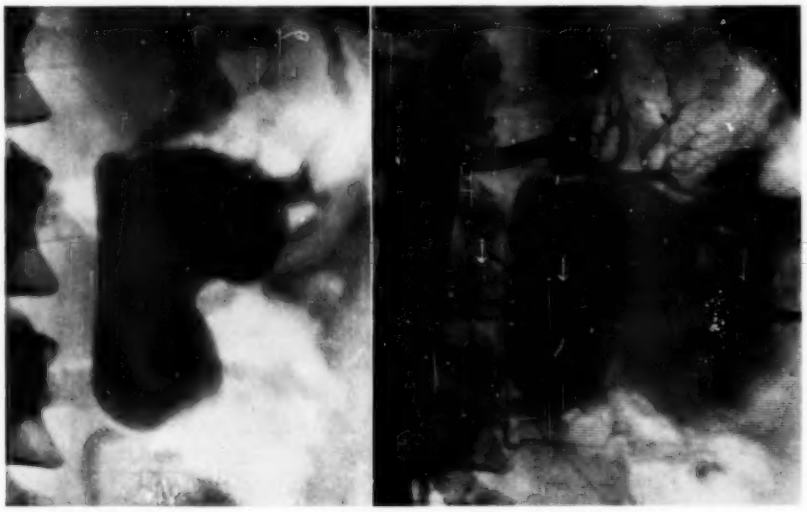
	Number of Kidneys	Number of Hydronephroses	
Normal supply of vessels	325	23	7.1 %
Accessory vessels	63	20	31.7 %
	388	43	

In this material there is thus a surplus calculated as a percentage of the number of hydronephroses in the group of kidneys with accessory vessels, compared with the group with a normal supply of vessels. Forty-three kidneys (68.3 %) with accessory vessels show no signs of hydro-



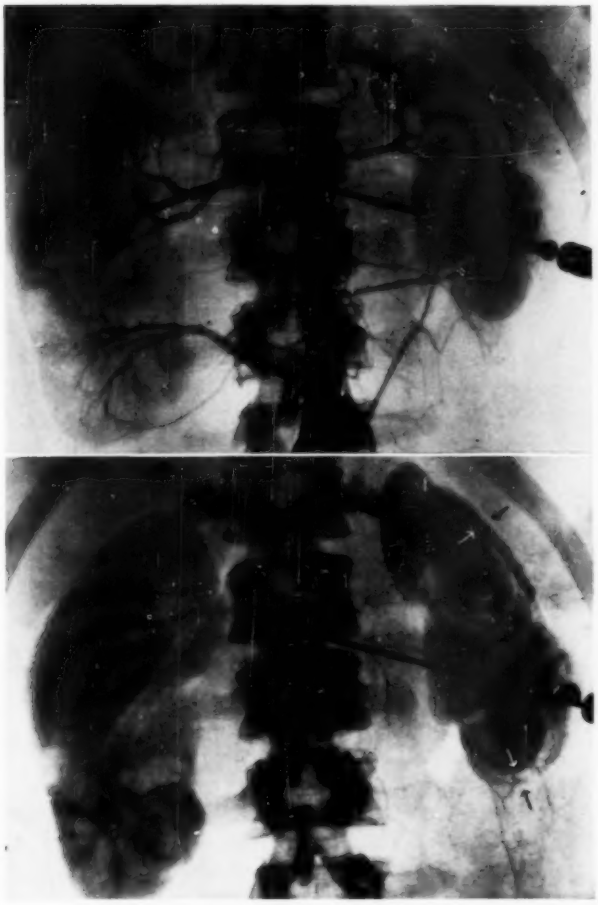
a. b.

Fig. 2. Hydronephrosis. a. Urography. b. Renal arteriography. Accessory vessel at the uretero-pelvic junction.



a. b.

Fig. 3. Hydronephrosis. a. Urography. b. Renal arteriography. Accessory vessel but not at the uretero-pelvic junction.



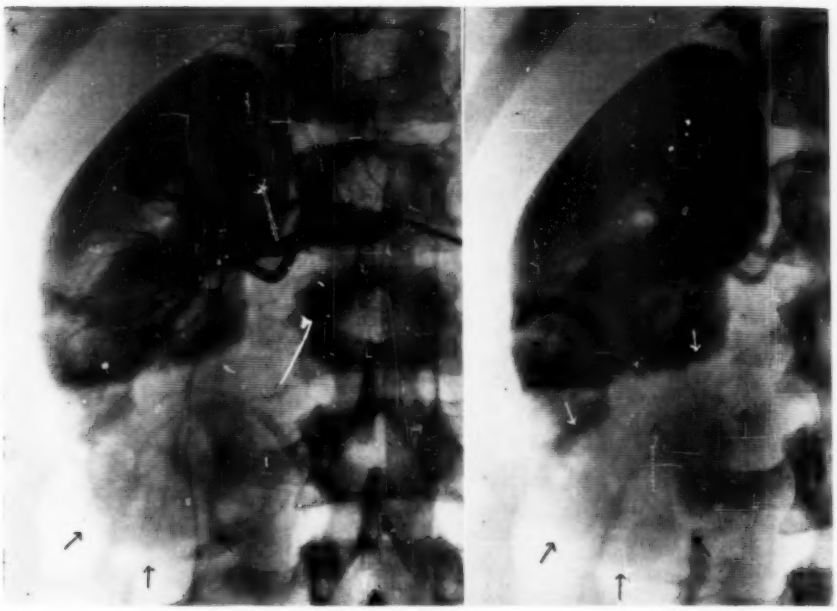
a.

b.

Fig. 4. a. Accessory vessels to both kidneys. On the left side severe hydronephrosis, previously contrast filled. b. 5 seconds later. Severely reduced renal parenchyma on left side.

nephrosis. There is therefore reason to believe that in the group of hydronephrosis with accessory vessels there are kidneys present, the accessory vessels of which have no connection with the hydronephrosis.

Hydronephroses appeared together with accessory vessels in 46.5 % of this material which agrees with what J. C. ANDERSSON found in his material of 72 kidneys in which hydronephrosis was present with accessory vessels in 43 %.



a. b.

Fig. 5. Same case as Fig. 4. a. Contrast medium injected into the upper artery of right kidney. b. 4 seconds later. Sharp demarcation between the supply areas of the two arteries.

In order to be able to decide roentgenologically whether an accessory vessel or a branch vessel, classified as normal, may be the cause of a hydronephrosis the renal pelvis should first be filled with contrast medium by means of excretion urography and renal arteriography performed with the patient prone (Figs. 2 a and b and Figs. 3 a and b). ÖSTLING et al. have pointed out how the kidney in hydronephrosis rotates around its long axis so that the hilum of the kidney comes to be directed ventrally and the ventrally running stretched vessels exert pressure effects upon the uretero-pelvic junction. With the patient prone, therefore, the uretero-pelvic junction constitutes the lowest point of the renal pelvis and is thus best assessed in that position. It appears to me that concomitant contrast filling of the renal pelvis and the vessels shows the connection between the vessels and hydronephrosis more clearly than when the vessels are first contrast filled and one then waits with the patient in an unaltered position until the medium is excreted into the pelvis.

The arteries of the kidney are end-arteries. In Fig. 4 a both arteries

of the right kidney have been contrast filled while in Figs. 5 a and b (same case), the contrast medium has been injected mainly into the upper renal artery. The arteriography clearly shows the sharp demarcation between the supply areas of the two arteries. Owing to this condition ligature of an accessory vessel must cause risk of disturbances in the circulation within the range of supply of the ligated vessel.

Figs. 4 a and b show the possibility of judging the thickness of the parenchyma layer in hydronephrosis by means of renal arteriography, the hydronephrotic left renal pelvis having been contrast filled in advance by excretion urography.

SUMMARY

The aortographic appearances of 388 kidneys have been studied with reference to the presence of accessory vessels at the lower part of the kidney. The appearance of hydronephrosis within the group with normal supply of vessels and the group with accessory vessels has been compared. The possibility of showing if a renal vessel is involved in hydronephrosis by first filling the pelvis with contrast medium and then performing renal arteriography is pointed out.

ZUSAMMENFASSUNG

Die aortographischen Bilder von 388 Nieren sind untersucht worden in Bezug auf das Vorhandensein von accessorischen Gefässen nach den unteren Teilen der Niere. Das Auftreten von Hydronephrose innerhalb der Gruppe mit normaler Gefässversorgung ist verglichen worden mit dem von Gruppen mit accessorischen Gefässen. Die Möglichkeit ist erwähnt zu zeigen, ob ein Nierengefäss mit Hydronephrose in Verbindung steht, dadurch dass man zuerst das Nierenbecken mit Kontrast gefüllt hat und so eine renale Arteriographie macht.

RÉSUMÉ

L'image de l'aortographie de 388 reins a été étudiée en considérant la présence de vaisseaux accessoires à la partie inférieure du rein. On a comparé l'apparition d'hydronéphrose dans le groupe avec arrivée normale de vaisseaux et dans le groupe avec vaisseaux accessoires. On a fait mention de la possibilité de montrer si un vaisseau rénal est engagé dans une hydronéphrose en remplissant d'abord le pelvis avec contraste et en effectuant ensuite une artériographie rénale.

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FROM THE ROENTGENDIAGNOSTIC DEPARTMENT (DIRECTOR: PROF. OLLE OLSSON),
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ANGIOGRAPHICALLY DIAGNOSED GLOMUS TUMOUR OF THE THIGH

by

Karl-Eric Borgström

Most glomera are situated beneath the subpapillary vessels between the skin and the subcutaneous tissue. They are commonest in the peripheral parts of the limbs. The function of these organs is to control the circulation and thereby the local peripheral temperature. Functionally, a glomus may be regarded as an arteriovenous shunt. It is built up of three parts: an arteriole, a shunt and draining veins. The anastomosis consists of a number of endothelial-lined channels wrapped in a mantle of large epithelioid cells, so-called glomus cells. This mantle is in turn surrounded by smooth muscle tissue and a rich network of non-medullated nerve fibres.

Pathologic anatomy. MASSON (1924) showed that the tumours known for the last two centuries as "painful, subcutaneous tubercles" arise from the glomera of the skin. Histologically, the glomus tumour or the glomangioma represents hyperplasia of all of the elements of the normal glomus. These tumours are usually confined to the skin of the limbs and are particularly common under the finger nails, *i. e.* where a glomus is also most common. Glomus tumours have also been seen, though less frequently, in other regions of the body. GERMAN (1945) described a glomus tumour of the triceps muscle and BRINDLEY (1949), of the mediastinum. Glomus tumours of the deeper tissues of the lower limbs have been reported by THOMAS (1933), BERGSTRAND (1937), HOFFMAN & GHORMLEY (1941) and MURRAY & STOUT (1942) etc.

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The occurrence of glomus tumours in regions in which glomera have never been demonstrated may be explained by the epithelioid cells being identical with ZIMMERMANN's pericytes, *i. e.* cells occurring in most parts of the body.

The glomangioma is practically always non-malignant, though the infiltrating growth of such tumours is on record (MURRAY & STOUT 1942).

Clinical aspects. The glomus tumour usually appears as a small, blue-red, slowly growing skin tumour. It is associated with extreme tenderness and by attacks of local recurrent burning pain, which may occur spontaneously or be provoked by heat, pressure, cold or mental excitement.

In the investigation of such burning pain in the thigh of a patient recently referred to the roentgen department, angiography gave the diagnosis of a glomus tumour.

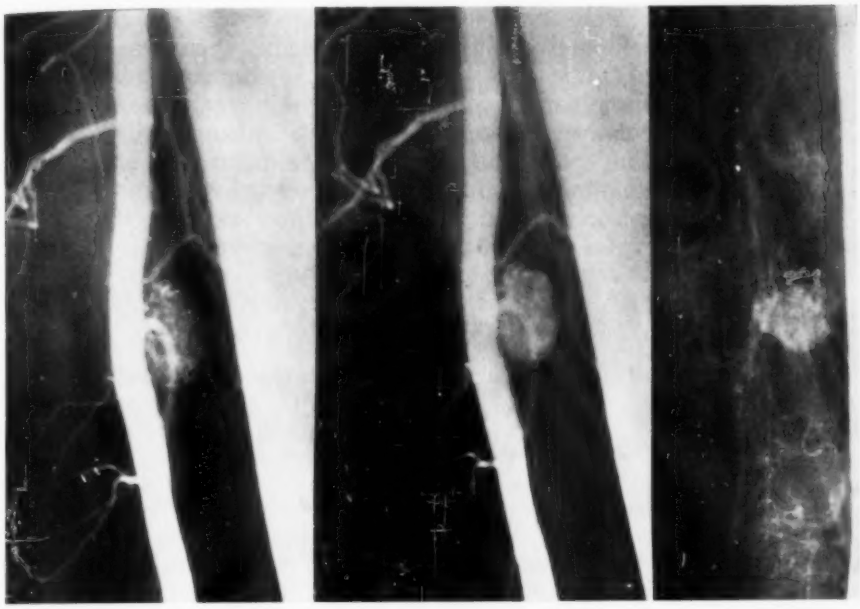
As a search of the literature failed to reveal any record of the diagnosis of a glomus tumour by angiography, it was thought that a report of this case might be of interest. (It should be stressed that the carotid body tumours diagnosed angiographically and described by IDBOHRN from our department (1951) have nothing in common with glomus tumours of the skin.)

Report of case: A man, aged 42, had had paroxysms of pain in the inner part of the left thigh for five years and for which he had been examined in various hospitals. The only signs of a pathologic condition were slight atrophy of the left thigh and local tenderness. In 1950 a neurinoma had been tentatively diagnosed and the tender area had been surgically explored. At operation it was observed that a limited area of a muscle bundle adjacent to the femur was extremely tender to palpation despite satisfactory lumbar anaesthesia. No tumour was detected.

In July, 1953, the patient was again admitted for investigation because of increasing disability from frequent recurrence of pain. This time the possibility of a glomus tumour was borne in mind.

On admission: The patient complained of continuous dull pain on the inner part of the left thigh, intensified on exertion or rapid movement of the leg. After the more acute pain had subsided a small spot in the scar (as a result of the aforementioned surgical exploration) remained tender to palpation. Occasionally the exacerbations were precipitated by mental excitement. *Physical examination*: As before, slight atrophy of the left thigh and local tenderness to palpation, were noted.

Angiography: Contrast medium (Umbradil 40 per cent, 30 ml and 25 ml) was injected into the left femoral artery at the level of the inguinal ligament. On the ventral side of the vessel and adjacent to the femur, a neoplasm, measuring 20 × 17 mm, was seen at the site found to be tender to palpation. It was slightly irregular in outline and consisted of a rich complex of entangled vessels of varying calibre (Fig. 1). The contrast medium passed through the tumour quicker than through the arterial branches, and before it had entered the capillaries, a filling of a large vein extending out from the tumour became apparent (Fig. 1 b). Roentgen diagnosis: Glomus tumour, adjacent to the femoral artery.



a. b. c.

Fig. 1. Vascular glomus tumour adjacent to the ventral aspect of the femoral artery. In b) the contrast medium has already passed into a large vein extending out from the cranial pole of the tumour; this was the only venous filling observed in this phase.

Operation: The tumour was extirpated without difficulty. It was encapsulated and measured 12 mm by 12 mm (Fig. 2). The growth was found to be rich in arteries, veins and nervous fibres.

Histology: The tumour was built up of vascular tissues. The cells lining the vascular spaces were relatively large with mediumsized, rounded nuclei and relatively scanty cytoplasm. The entire tumour was enclosed within a capsule. The tumour showed no signs of malignancy. Diagnosis: Glomus tumour.

The post-operative course was uneventful. The patient left hospital one week after operation and when seen two months later had no recurrence of pain.

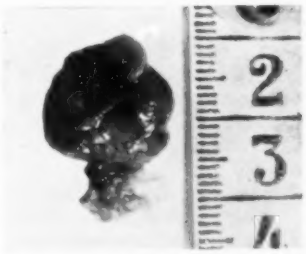


Fig. 2. Glomus tumour. Operative specimen.

Comments

Angiography revealed a small, well-defined tumour in the left thigh. The tumour consisted of a mass of vessels and showed the characteristics of an arteriovenous shunt. On the basis of these observations the tumour

was diagnosed roentgenographically as a glomus tumour. Microscopic examination of the operative specimen confirmed the roentgen diagnosis.

For a glomus tumour to be diagnosed roentgenographically, its make-up must be dominated by the vascular component. The proportion between the vascular spaces and the masses of glomus cells may vary widely: the vascular spaces may dominate the picture, or, on the other hand, the mass of glomus cells may constitute the characteristic feature.

In the investigation of localised pain of unknown origin in the extremities the possibility of a glomus tumour of the deeper tissues should be borne in mind. In such cases angiography may prove useful.

SUMMARY

A case is described of a glomus tumour of the deeper tissues of the thigh, diagnosed angiographically.

ZUSAMMENFASSUNG

Ein angiographisch diagnostizierter Glomustumor in den tiefen Gewebsschichten des Oberschenkels wird beschrieben.

RÉSUMÉ

Présentation d'un cas de tumeur glomique des tissus profonds de la cuisse, diagnostiqué angiographiquement.

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FROM THE NEUROSURGICAL CENTRE (DIRECTOR: PROF. AGR. MARCEL DAVID),
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COMPARISON BETWEEN ENCEPHALOGRAPHY AND VENTRICULOGRAPHY

by

M. David, G. Ruggiero and *J. Talairach*

For the last eight months encephalographic examinations in the Neuroradiologic Department of the Sainte Anne Hospital have been performed according to the technique described by LINDGREN (and recently presented at the French Neurologic Society by one of us — R.). The main principle of this technique consists of controlling the introduction of the air into the ventricular and subarachnoidal systems by injecting it in small amounts. Moreover, the contrast is usually injected before any, except a few drops, of fluid are withdrawn, the total amount of the latter always being less than the amount of air introduced. These precautions very much reduce the danger of cerebral and cerebellar herniation. The entire ventricular and cisternal systems may usually be visualised satisfactorily by the injection of limited quantities of air, in fact, encephalography never (except, of course, cases with a marked degree of ventricular dilatation) requires more than 25—30 ml of air; in some cases even 5—10 ml may give useful results.

In our clinic this type of encephalographic examination is called 'encéphalographie fractionnée' whilst the examination by either total or subtotal substitution of the fluid with air has been given the name of 'encéphalographie thérapeutique'. The latter technique is, in our opinion, much less useful when an encephalographic examination is carried out for diagnostic purposes. Ventriculography in our clinic is performed by studying the different portions of the ventricular system separately, according to the technique mainly developed by LYSHOLM. Examinations in which only four or five standard projections are obtained, have been definitively abandoned.

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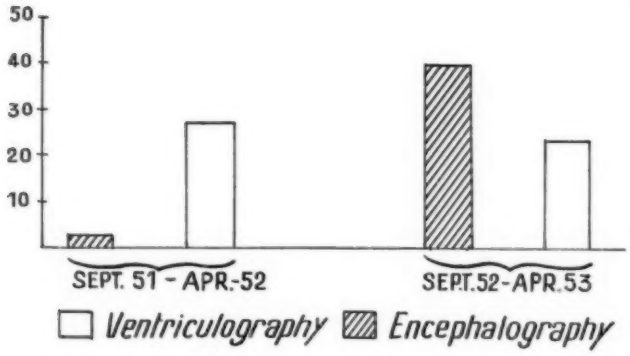

The material on which this study is based consists of 221 'pneumographies fractionnées', *i. e.* 190 encephalographies, 30 ventriculographies and 1 subdurography. All the examinations were carried out by the Neuroradiologist in the Roentgen Department. The material is listed in Table 1. In seven patients, both ventriculography and encephalography were performed.

This article will not deal with the diagnostic value of encephalography and ventriculography nor try to establish which kind of examination should be carried out — or performed first — in the various brain conditions. In analysing our material, we only wish to answer certain questions which arise from the opinion — apparently still held in many countries — that encephalography is contra-indicated in cases of brain tumours and in practically all cases with increased intracranial pressure. The diagram gives some idea of the value which is now attributed by us to each of the two methods. The questions are:

1) Is encephalography absolutely contra-indicated in brain tumours?
2) Is encephalography more dangerous than ventriculography?
3) Are there types of brain tumour or pathologic conditions in which encephalography has to be considered more dangerous than ventriculography?

We shall examine the encephalographic and the ventriculographic material separately.

Encephalography. Out of forty cases of brain tumour (Table 1), three had two examinations: a case of multiple intracerebral metastases with one situated in the posterior fossa, a case of meningioma of the tuberculum sellae and a case of temporal glioma. In these three cases, encephalography had been repeated at an interval varying from some weeks to many months. In the forty cases, there were twelve tumours which extended into the posterior fossa and one tumour probably extending into the

posterior fossa. Twenty-five patients showed papilloedema, fourteen had no papilloedema, one was doubtful. In eight cases, papilloedema had been considered by the ophthalmologist (BREGEAT) as being very marked. Among the last-named cases there were four tumours in the posterior fossa and one case of metastases involving the posterior fossa.

Table 1

	Encephalography	Ventriculography	Subduro-graphy
Verified expansive processes	35	16	1
Tumours	33	14	
Abscesses	2	1	
Hematomas		1	1
Non-verified expansive processes, but with certain clinical and radiologic features	5	7	
Tumours	4	7	
Aneurysms	1		
Doubtful	8	2	
Still in hospital	6		
Patient discharged himself	1		
Clinical notes lost	1	2	
Non-expansive diseases and normal cases	142	5	
	190	30	1

Accidents. Accidents were observed in four cases; these are briefly detailed:

1. C. R., male, aged 21. Verified fibrous astrocytoma in the left cerebellar hemisphere. Papilloedema. Immediately after the lumbar puncture and the injection of a little air, the patient had a peculiar attack consisting of loss of consciousness and psychomotor automatisms. Similar attacks had previously been observed in the ward and it had not been possible to explain them. The examination was interrupted and coramine-lobeline injected intramuscularly. The patient recovered after a few minutes. Fifteen days later, he was successfully operated upon. There was no cerebellar herniation.

2. S. H., male, aged 53. Verified acoustic neurinoma on the left side. Choked disk. After the injection of 7—8 ml of air and withdrawal of 3—4 ml of liquid, the patient had a seizure. Coramine was injected and the examination was continued by taking all the necessary projections sitting. The patient recovered almost immediately. The cerebrospinal fluid was xanthochromic. The patient, whose general condition was very poor even before encephalography, was successfully operated upon about one hour later; he was discharged, completely recovered, some weeks afterwards.

3. P. P., female, aged 23. Verified intracerebellar tumour situated superiorly. Severely choked disk. Lumbar puncture was inadvertently performed with one of the two cocks of the double-way needle left open. Not less than 5 ml of liquid escaped from the subarachnoidal space before any air was injected. The patient suddenly became unconscious and pale. Very rapid horizontal nystagmus was present. After 8 ml of air had been injected the needle was taken out and the patient was placed in the supine position with the head down. Coramine-lobeline was injected twice at an interval of about ten minutes. Almost

immediately after the patient had been placed in the supine position, she recovered consciousness and the colour of her face became normal; the pulse, which was weak and rapid, improved although hyperpnoea occurred and lasted some minutes. During the attack, there had been unequal pupils (R > L). No stiffness of the neck was observed. About ten minutes after the loss of consciousness the patient's condition became normal again. She was successfully operated upon two hours after the encephalography. Operation revealed a marked cerebellar herniation which had been previously noticed in the films, *i. e.* it was very probably present before the encephalographic examination.

4. H. C., female, aged 41. Verified meningioma attached to the posterior surface of the petrous bone, extending towards the occipital foramen. Markedly choked disk. No tumour in the posterior fossa had been suspected from the clinical signs. The encephalographic examination revealed the existence of a tumour in the posterior fossa and moreover that cerebellar herniation was also present. Due to her unsatisfactory general condition, the patient was not operated upon. She died the following day. Autopsy confirmed a moderate degree of cerebellar herniation as shown by the encephalograms.

Seven cases were operated upon immediately after encephalography with total removal of the tumour in six. Other cases were operated upon after a delay varying from one day to more than a month. Among the cases immediately operated upon, were two operative fatalities. Both of these were acute cases and practically comatose when admitted.

There were eight operative fatalities out of a total of thirty-three cases. Out of the thirty cases in which the tumour was totally removed, there were seven operative fatalities, or twenty-three per cent. Operative mortality of cases which were operated upon immediately, or almost immediately, after encephalography, was practically zero, if we exclude the two patients who were almost comatose before the examination. It is obvious, on the other hand, that encephalography cannot influence the result of the operation when this is performed after a certain passage of time.

Ventriculography was performed in twenty-three cases of brain tumours: nine tumours in the posterior fossa, eleven supra-tentorial tumours, two tumours growing into the posterior fossa, and one tumour growing probably into the posterior fossa. A choked disk was present in eighteen cases, the condition being very severe in two.

Accidents. In four cases accidents were observed which must be attributed to ventriculography.

1. B. R., female, aged 29. Verified extracerebral tumour in the region of the foramen magnum; signs of von Recklinghausen's disease. Choked disk. Some hours after ventriculography, the patient showed severe impairment of respiration and died with signs of pulmonary oedema. Before the ventriculography, her general condition had been good. Autopsy revealed very marked cerebellar herniation.

2. L.S., female, aged 36. Verified deep temporal glioma. During the ventriculography, the patient became comatose. In spite of immediate intervention, the patient died on the operating table.

3. L. J., male, aged 40. Verified enormous extracerebral intraventricular tumour, probably a meningioma. Choked disk. The patient became comatose immediately after ventriculography. Successful and immediate extirpation of the tumour. The patient is still in hospital and his general condition is satisfactory.

4. H. L., male, aged 45. Verified pontine glioma. Choked disk. The patient became comatose during ventriculography and died some hours after surgical exploration of the posterior fossa.

Out of sixteen cases operated upon (extirpation of the tumour), there were six operative fatalities. In another case, a decompression flap operation was performed immediately after ventriculography had showed an inoperable tumour. The patient died two days later.

Discussion

We feel that the questions at the beginning of this article may be answered as follows:

1) Encephalography performed according to the technique described by LINDGREN is not contra-indicated in cases of brain tumours. As a matter of fact, such an examination was carried out in a rather high number of cases (forty) with ten per cent of accidents. This percentage may be reduced to five if we leave out the case in which a technical mistake was made and the case not operated upon in spite of the encephalographic diagnosis of a tumour in the posterior fossa with cerebellar herniation.

2) Encephalography is not more dangerous than ventriculography. As a matter of fact, the accidents due to ventriculography totalled seventeen per cent. This finding has much value, as, in the present series, there were many more encephalographies than ventriculographies.

3) Encephalography is not more dangerous than ventriculography in certain types of tumour or pathologic conditions. In fact the number of cases of posterior fossa tumours and cases with choked disk was almost the same in both the encephalographic and ventriculographic series. We feel, on the other hand, that encephalography presents a real advantage: it allows a positive diagnosis of cerebellar herniation before operation.

The examination of the material showed a difference in the immediate operative result between the encephalographic and ventriculographic groups. The operative mortality was higher in the latter but the series which has been presented is too small for evaluating such a finding. There are many factors which influence the result of a surgical operation.

Finally, certain subjective impressions of the surgeon himself in the operating theatre seem to speak in favour of encephalography. The brain always appears much less congested following encephalography than after ventriculography.

Conclusions

From a pure neurosurgical standpoint, there are reasons to believe that encephalography is not more dangerous than ventriculography and moreover presents certain advantages. In our clinic, encephalography is tending to replace ventriculography.

SUMMARY

A critical review of forty cases of brain tumours in which encephalography was performed and twenty-three cases of brain tumour in which ventriculography was carried out. Encephalography according to the technique described by LINDGREN is not more dangerous than ventriculography and presents the advantage of revealing cerebellar herniation and affecting the brain less.

ZUSAMMENFASSUNG

Vierzig Hirntumorfälle, bei denen eine Enzephalographie ausgeführt worden ist, und 23 Fälle mit Hirntumoren, die mit Ventrikulographie untersucht worden sind, wurden einer kritischen Durchsicht unterworfen. Die Enzephalographie nach der von LINDGREN beschriebenen Methode ist nicht gefährlicher als die Ventrikulographie und bietet den Vorteil, dass eine Hernierung des Kleingehirns nachgewiesen werden kann und das Gehirn weniger in Mitleidenschaft gezogen wird.

RÉSUMÉ

Etude critique de quarante cas de tumeurs cérébrales où une encéphalographie à été faite et de vingt-trois cas de tumeurs cérébrales où une ventriculographie a été pratiquée. L'encéphalographie d'après la méthode décrite par LINDGREN n'est pas plus dangereuse que la ventriculographie et présente l'avantage de révéler l'engagement cérébelleux et d'être moins nocive pour le cerveau.

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INFANTILE CORTICAL HYPEROSTOSIS

by

Jason L. Meadors and *H. Stephen Weens*

Introduction

Since the recognition of infantile cortical hyperostosis as a clinical and radiologic entity by CAFFEY and SILVERMAN (6) in 1945, more than fifty cases have been reported in the literature (5). Though some of the cases described in early reports (6, 14) are now believed to represent other disorders, there can be little doubt that the clinical and radiologic manifestations in most of these patients warranted the concept of a new clinical syndrome. Very likely in the past, cases of infantile cortical hyperostosis have been mistaken for cases of atypical scurvy, syphilis, and other diseases affecting bony structures. It is noteworthy that as early as 1930 ROSKE (10) considered this condition as a new unusual bone disorder in a case which would be classified today as infantile cortical hyperostosis. It is becoming increasingly apparent that this condition is probably not uncommon.

Infantile cortical hyperostosis is a disease of presently unknown etiology which occurs in early infancy. It is characterized by cortical hyperostosis of certain bones associated with painful soft tissue swelling over the affected structures. Slight fever and irritability are usually prominent features, especially early in the disease, though these symptoms may be minimal or absent. The extensive osseous changes are usually followed by complete regression and bone development is rarely affected.

It is the purpose of this paper to describe eight cases of infantile cortical hyperostosis which have been observed at Grady Memorial Hospital in the time period of 1945 to 1953. The radiologic and clinical findings of these cases will be described and possible etiologic factors of this condition will be discussed.

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Fig. 1. Case I. Marked periosteal thickening surrounding entire left clavicle.

Fig. 2. Case I. Cortical hyperostosis of right ribs in anterior axillary area.

Case I: J. S., a five months old Negro male, was seen with soft tissue swelling over the left clavicle and irritability of ten days' duration. One week later soft tissue swelling over the right lower rib cage and mandible was noted. The past history was not contributory.

Physical Examination: Temperature 38.3° C. There was a tender, soft tissue swelling over the left clavicle, right lower rib cage, and mandible. The liver was barely palpable.

Laboratory: Kahn negative. First strength tuberculin test negative. Urine negative. RBC 4.57 mill. Hemoglobin 13.6 %. WBC 27,700 with 47 % segmentors, 43 % lymphocytes, 8 monocytes, 1 % eosinophils and 1 basophil. Sickle cell preparation negative. Blood cultures: No growth. Biopsy of the left clavicle showed callus formation and no evidence of inflammatory process.

Fig. 3.

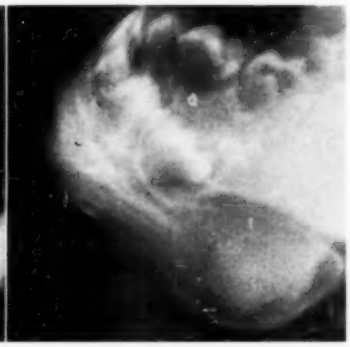

Fig. 4.

Figs. 3 & 4. Case I. AP and lateral views. The entire mandible is surrounded by a thick layer of periosteal bone which blends with the original cortex.

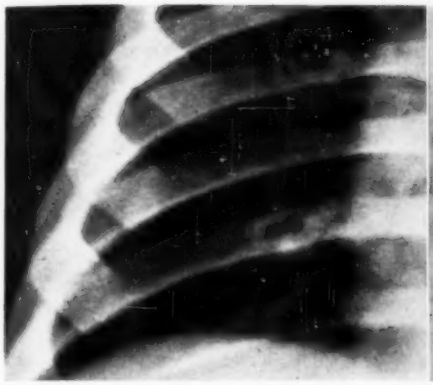

Fig. 5. Case I. Two months later. The ribs appear almost normal.

Fig. 6. Case I. Follow-up roentgenograms after two months. The clavicle remains thickened. The bone appears more compact.

Radiographic Examination: Uniform thickening of the cortex of the left clavicle (Fig. 1), axillary and anterior portions of the right third, fourth, fifth, sixth and seventh ribs (Fig. 2), and of the entire mandible (Figs. 3 and 4).

Clinical Course: The fever up to 38.3° C continued for one week after hospital admission. The total time of hospitalization was five weeks without striking change in the clinical appearance of the soft tissue swellings. Follow-up radiographs two months later showed considerable improvement in the appearance of the ribs (Fig. 5), clavicle (Fig. 6), and mandible. The cortical changes were more compact and the soft tissue changes had disappeared.

Case II: L. W., a four months old Negro female, was seen with right facial swelling, irritability and fever of ten days' duration. The past history was not remarkable.

Physical Examination: Temperature 37.7° C. A firm, tender, non-movable swelling over the right mandible was present.

Laboratory: Urine negative. Kahn negative. Hemoglobin 14 g%. WBC 8,500 with 38 % segmentors, 60 % lymphocytes and 2 % monocytes. Alkaline phosphatase — 5 Bodansky units. Serum calcium 9.1 mg%.

Radiographic Examination: Marked cortical thickening of the mandible, most prominently seen on the right side and involving both the ascending ramus and body of the mandible. A bone survey showed no other sites of involvement.

Clinical Course: The fever disappeared after two days and at no time exceeded 37.7° C. The irritability and facial swelling gradually subsided. The patient was discharged after ten days.

Case III: N. S., a seven months old Negro male, was seen because of fever, irritability and swelling of the right posterior chest wall of five days' duration. The past history was not remarkable.

Physical Examination: Temperature 38.3° C. There was tender swelling over the right lower chest wall and questionable right facial swelling.

Fig. 7. Case III. Lamellated cortical thickening of left ribs in mid-axillary line.

Fig. 8. Case IV. Cortical thickening of horizontal ramus of left mandible.

Laboratory: Kahn negative. First strength tuberculin test negative. Urine negative. RBC 4.9 mill. Hemoglobin 8.2 g%. WBC 14,400 with 43 % segmentors, 57 % lymphocytes. Sedimentation rate 123 mm per hour. Sickle cell preparation negative. Serum calcium 10.4 mg%. Serum phosphorus 5.1 mg%.

Clinical Course: A low grade fever persisted for several weeks. Within three weeks the right chest wall swelling and facial swelling greatly decreased and the patient became gradually asymptomatic. No other sites of swelling were noted during this time.

Radiographic Findings: The initial roentgenogram of the chest showed cortical thickening involving the left sixth, seventh and eighth ribs (Fig. 7) and the right seventh, eighth and ninth ribs. Films of the mandible and long bones at this time showed no changes. Repeat roentgenograms after two weeks demonstrated a small amount of periosteal proliferation of the right mandible and right clavicle. The films of the ribs after three weeks showed a laminated and more compact appearance to the cortical thickening.

Case IV: S. W., a four months old Negro female, was seen in the outpatient department because of left facial swelling, low grade fever, and irritability of one week's duration.

Physical Examination: Temperature 38.3° C. There was swelling, induration and tenderness over the left mandible. No additional sites of soft tissue swelling were present.

Laboratory: No laboratory work up.

Radiographic Examination: There was cortical thickening of the body of the left mandible (Fig. 8), which after three weeks showed a more compact appearance.

Clinical Course: Penicillin was given for thirty days without striking effect. During this time the fever and irritability disappeared and facial swelling became less prominent.

Follow-up examination of the patient two years later revealed that there had been no recurrences and there was no residual facial asymmetry. The patient was a normal, healthy-appearing 2 1/2 year old child. Radiographs of the mandible and of the long

Fig. 9. Case IV. Follow-up roentgenogram two years later. The mandible appears normal.

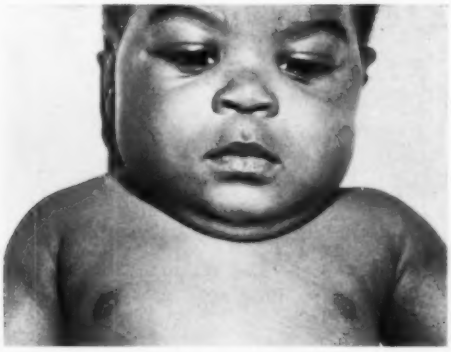

Fig. 10. Case V. Marked bilateral facial swelling in region of mandible. Soft tissue swelling over right clavicle.

bones at this time demonstrated no pathological changes. The cortical contour of the mandible was normal (Fig. 9).

Case V: N. E., a six months old Negro male, developed irritability and fever at the age of four months. One month later bilateral facial swelling appeared which was followed after several days by soft tissue swelling over the right clavicle. He was seen at another hospital where Ludwig's angina was suspected and penicillin was given without clinical response.

The past history was not remarkable.

Physical Examination: Temperature 37.3° C. There was bilateral facial swelling (Fig. 10) and swelling of soft tissues over the right clavicle (Fig. 11). No other soft tissue swellings were present.

Fig. 11. Case V. Soft tissue swelling over clavicle causing marked differences in the contour of the shoulders.

Fig. 12. Case V. Extensive cortical thickening involving entire mandible.

Fig. 13. Case V. Marked increase in thickness of right clavicle due to extensive periosteal new bone formation.

Fig. 14. Case V. Five months later. Mandible. The cortical thickening has largely subsided.

Laboratory Findings: Kahn negative. First strength tuberculin test negative. Urine negative. RBC 5.2 mill. Hemoglobin 9.2 g%. Sickle cell preparation negative. WBC 11,350, with 2 % eosinophils, 2 % basophils, 46 % segmentors, 45 % lymphocytes and 5 % monocytes. Blood culture: No growth.

Clinical Course: The patient was hospitalized for ten days and during this time the soft tissue swelling decreased remarkably.

Fig. 15. Case V. Five months later. Clavicle remains deformed. New cortex clearly visualized.

Fig. 16. Case VI. Right hand. Soft tissue swelling of index finger and fourth finger.

Fig. 17. Case VI. Right hand one week later. Slight periosteal thickening of proximal phalanx of index finger.

Fig. 18. Case VI. Left hand. Periosteal thickening of first, second and third metacarpal bones.

Radiographic Examination: There was extensive cortical thickening involving the entire mandible (Fig. 12) and right clavicle (Fig. 13). When examined five months later he was asymptomatic without residual soft tissue swelling. Films of the mandible (Fig. 14) showed residual changes but the thickening of cortex was more compact. The clavicle showed residual thickening but a more normal structural pattern (Fig. 15).

Case VI: V. C., a six months old Negro female, developed swelling of the first phalangeal joint of the right index finger, fever and irritability one month prior to admission, followed by swelling over the right fourth and fifth metacarpal bones three weeks later. Several days prior to admission swelling over the proximal right forearm, dorsum of the right foot, and left face occurred.

Past History: Right-sided Erb's palsy incident to delivery, otherwise not remarkable. There was no history of excessive vitamin intake.

Laboratory Examination: Kahn negative. First strength tuberculin skin test negative. Urine negative. RBC 3.98 mill. Hemoglobin 8.7 g%. Sedimentation rate 12 mm per hour. Sickle cell preparation repeatedly negative. WBC 8,650 with 1 % eosinophils, 40 % segmentors, 58 % lymphocytes and 1 % monocytes. Blood culture: No growth.

Physical Examination: Temperature 37.2° C. There was minimal soft tissue swelling and tenderness over the left mandible; marked soft tissue swelling was present at the base of the right index finger, the proximal two-thirds of the right fourth finger (Fig. 16), the dorsum of the right foot and the upper portion of the right forearm.

Radiographic Examination: The long bones and the mandible were normal. There was cortical thickening of the shaft of the right fourth metacarpal and the left fourth and fifth metatarsals. No changes of the bones of the right foot were demonstrated.

After one week there was minimal periosteal proliferation of the shaft of the proximal phalanx of the right index finger (Fig. 17). Though the soft tissue swelling of the right fourth finger was visible radiographically, there were no demonstrable underlying bone changes. Films of the left hand after one week demonstrated periosteal proliferation involving the first, second and third metacarpals, a finding which was not present one week previously (Fig. 18). Radiographs of the right foot after one week demonstrated periosteal proliferation involving the right first, second, fourth and fifth metatarsal bones.

Clinical Course: The patient was hospitalized for a period of seventeen days during which time the soft tissue swelling, fever and irritability gradually subsided.

Case VII: J. D., a four months old Negro male, was first seen because of symptoms of an upper respiratory infection, vomiting, and soft tissue swelling of the right face of five days' duration. Irritability, diarrhea and fever to 38.3° C had been present.

Past History: Dietary and vitamin intakes were adequate. He was breast fed until the age of three weeks, at which time this was discontinued because the mother developed jaundice, the nature of which was unknown.

Physical Examination: Temperature 38° C. Lesions of oral moniliasis were present in the mouth. There was a firm, tender swelling over the right mandible. No additional areas of soft tissue swelling were noted.

Laboratory Findings: Kahn negative. Urine negative. RBC 4.2 mill. Hemoglobin 11.4 g%, sickle cell preparation negative. WBC 16,000 with 4 % stabs, 57 % segmentors and 39 % lymphocytes. Blood culture: No growth.

Radiographic Examination: The mandible showed 1—2 mm of cortical thickening along the inferior aspect of the body of the right mandible. Films of the long bones and ribs demonstrated no additional bone changes.

Clinical Course: Vomiting and diarrhea were adequately controlled with oral fluids and sulfadiazine. The oral moniliasis was controlled with local measures. During the course of hospitalization (13 days) the soft tissue swelling over the right side of the face decreased. One month later there was marked cortical thickening along the inferior aspect of the left mandible demonstrated and increase in the thickening cortex of the right mandible with the changes on this side having a more compact appearance than that on the left side.

Two days after these radiographs were made the patient returned with swelling over the left mandible, a finding which had not heretofore been noted. The swelling of the right face increased markedly concomitant with the left facial swelling, and low grade fever and irritability returned. These changes gradually subsided and one month later the soft tissue swelling had considerably decreased. There had been no additional new sites of soft tissue swelling in the interim and radiographs of the long bones and ribs demonstrated no new bone lesions.

Case VIII: J. M., a three and one-half months old Negro male, developed bilateral facial swelling, low grade fever and irritability two weeks previously.

The past history was not remarkable. The dietary and vitamin intake were adequate.

Physical Examination: Temperature 37.5° C. There was rather marked soft tissue swelling over the right mandible, and less, but definite, swelling over the left mandible. There were no other sites of soft tissue swelling demonstrable.

Laboratory: Kahn negative. Urine negative. Sickle cell preparation negative. Hemoglobin 9.56 g%. Hematocrit 33. WBC 15,450 with 1 % eosinophils, 2 % stabs, 60 % segmentors and 37 % lymphocytes. Blood cultures: No growth.

Radiographic Examination: Films of the mandible showed cortical thickening of the body of the mandible bilaterally. There was early periosteal proliferation along the axillary aspect of the left fifth rib. There were no other areas of cortical thickening demonstrable.

Clinical Course: The patient was hospitalized for a period of seven days during which time he ran a low grade fever. During the period of observation there was no remarkable change in the appearance of the facial swelling and no new areas of soft tissue swelling occurred. Two weeks after discharge from the hospital the facial swelling had decreased slightly and there was now minimal soft tissue swelling over the left anterior and lateral chest wall. Radiographs of the chest at this time demonstrated further increase in the cortical proliferation which had previously been seen to involve the left fifth rib. Fever and irritability were absent by now and soft tissue swelling resolved within two weeks.

Discussion

The initial symptom of infantile cortical hyperostosis is usually irritability which is often, but not invariably, associated with slight temperature elevation. Occasionally, however, the fever may be spiking, exceeding 39.4° C (7). Within a few days or weeks the patient may develop brawny, deep, tender, soft tissue swellings without regional lymphadenopathy. While these soft tissue swellings appear very rapidly, they regress slowly, requiring sometimes many months to disappear. Beneath these soft tissue changes, the bony structures may exhibit striking thickening of cortical bone. It is the radiographic demonstration of these periosteal bone changes which has motivated the description of this clinical syndrome.

Pleurisy with small amounts of sterile pleural fluid has been reported in a small number of cases with extensive rib involvement (6). Two of our cases showed rib changes but there was no pleural fluid demonstrable.

Though the radiographic changes are very prominent, they are not pathognomonic, consisting only of cortical hyperplasia as the result of periosteal proliferation. The distribution of the osseous changes however is rather striking and when associated with the otherwise non-specific clinical picture, becomes diagnostic. The mandible and clavicle are most frequently affected, though it is not unusual to observe involvement of any of the long bones, ribs, scapula, and even cranial bones (18). Involvement of the vertebrae, carpus and tarsus has apparently not been reported (12). In one of our cases, phalangeal involvement was noted,

a heretofore unrecognized site of involvement to our knowledge. As healing of the bony lesions occurs, the thickening of the cortex may assume a laminated appearance.

There may be a delay between the occurrence of soft tissue swelling and the radiographic demonstration of bony changes. For this reason, roentgen examination should be performed for several weeks following appearance of soft tissue swelling. Conversely, there may be radiographically visible cortical changes without clinical evidence of overlying soft tissue swelling. It is therefore very likely that many of the milder cases may escape detection as there is no clinical indication for the need of roentgen examination.

The laboratory findings have proved to be of little value. Leukocytosis, anemia and increased sedimentation rate may be present during the early stage of the disease. Alkaline phosphatase determinations may show slight elevation depending upon the extent of osseous involvement. The serum phosphorus and calcium are normal and serologic tests for syphilis are negative. Blood cultures have failed to produce bacterial growth as have aspiration samples of affected bones and soft tissues.

The disease runs its course unaffected by any means of therapy with the possible exception of administration of adrenal cortical hormones (3). Thus chemotherapy, vitamins, antihistamines, and irradiation have been ineffectual (12). The disease is usually self limited leading to a spontaneous cure, which may require a period of several months. Remissions and exacerbations may occur and it is interesting that changes in different bones may be progressing and healing at the same time. While there are usually no sequalae to the disease, CAFFEY recently described a case which developed bony bridges between the radius and ulna causing impaired motion of the forearm (5). In this patient, bony bridges formed also between several ribs. Persistent ventral tibial bowing associated with marked thinning of the cortical bones has also been observed as the result of this condition (13).

A small number of patients afflicted by this disorder have died, probably as the result of an intercurrent infection such as gastroenteritis and mastoiditis (16, 9, 8). MATHESON postulates an unusual susceptibility to infection in these patients (8).

While the differential diagnosis is usually not difficult, it is noteworthy that many other diagnoses have been originally considered in cases of infantile cortical hyperostosis. Osteomyelitis, scurvy, syphilis, unrecognized trauma, tumor, parotitis, poliomyelitis, rheumatic fever, and leukemia are prone to be confused with this disease. Proper clinical, radiologic and laboratory examinations will readily differentiate most of these conditions from infantile cortical hyperostosis and will not be elaborated upon here. The differentiation from hypervitaminosis A

deserves, however, special consideration since some of the cases described in early reports as infantile cortical hyperostosis are now recognized as cases of hypervitaminosis A (6, 14). Excessive intake of vitamin A may produce periosteal proliferation resulting in cortical overgrowth,strikingly similar to those observed in patients with infantile cortical hyperostosis (15, 11). Characteristically this condition occurs after one year of age in contrast to infantile cortical hyperostosis which is encountered during the first half year of life or even in utero (1). Lack of mandibular involvement, a history of chronic excessive vitamin A intake, elevated vitamin A blood levels, and prompt disappearance of clinical symptoms after withdrawal of vitamin A serve to distinguish this disorder (4). Likewise, it is of importance that while metatarsal involvement may occasionally occur in infantile cortical hyperostosis, it is a very common and characteristic feature of hypervitaminosis A.

It appears interesting that all of our cases were of the Negro race, though our Pediatric Service has approximately equal numbers of white and Negro patients. Other series of cases indicate that this is not a disease predominant in the Negro population.

At present the etiology of infantile cortical hyperostosis remains obscure. The clinical symptomatology of this condition, especially the presence of fever and leukocytosis, has led many investigators to the belief that the disease may represent an infectious disorder. Extensive laboratory studies as well as biopsies have failed to substantiate this contention, and in none of the cases could a definite infectious agent as a significant factor in the development of this disease be established.

There is likewise, no sufficient evidence to incriminate derangements of mineral metabolism or endocrine disturbances as etiologic factors in infantile cortical hyperostosis.

Other authors have suggested that this disease may be attributed to a deficiency of embryonal osteogenesis (9). Faulty blood supply to the soft tissues and bony structures, perhaps in conjunction with unusual stress, is considered by some investigators to play an important rôle in the pathogenesis of this clinical syndrome. This concept is supported by histologic studies which reveal intimal thickening of the blood vessels supplying the affected areas as well as necrosis of the soft tissues overlying the periosteal proliferation (12, 8).

It is noteworthy that infantile cortical hyperostosis has been observed in several siblings (16, 1, 2) and lately also in a father and child (17). These observations suggest that the development of this condition may be in some manner genetically conditioned. It remains to be shown, however, whether these hereditary factors are alone responsible for the occurrence of the described soft tissue and bone changes.

SUMMARY

Infantile cortical hyperostosis is a disease of unknown etiology occurring during the first six months of life. The syndrome consists of cortical thickening of certain bones, painful soft tissue swellings overlying these bony lesions, fever, anemia, and leukocytosis. The clinical and radiographic findings of eight cases of this disorder are described and possible etiologic factors are discussed. A case with phalangeal involvement, an unusual site of occurrence is included.

ZUSAMMENFASSUNG

Die infantile corticale Hyperostose ist eine Krankheit mit unbekannter Ätiologie. Sie tritt während der 6 ersten Lebensmonate auf. Das Syndrom besteht aus corticaler Verdickung gewisser Knochen, schmerzhaften Anschwellungen der über den Knochenveränderungen liegenden Weichteile, Fieber, Anämie sowie Leukocytose. Die klinischen und röntgenologischen Befunde in 8 derartigen Fällen mit dieser Störung werden beschrieben und mögliche ätiologische Faktoren werden besprochen. Ein Fall mit einem phalangealen Prozess, einer ungewöhnlichen Lokalisation, ist darin miteinbegriffen.

RÉSUMÉ

L'hyperostose corticale infantile est une affection d'étiologie inconnue qui survient dans les six premiers mois de la vie. Ce syndrome consiste en épaississements corticaux de certains os, tuméfactions douloureuses des parties molles sus-jacentes à ces lésions osseuses, fièvre, anémie et leucocytose. Les auteurs décrivent les signes cliniques et radiologiques de huit cas de cette maladie et discutent les facteurs étiologiques possibles. Parmi ces cas figure l'atteinte d'une phalange, localisation inhabituelle de la maladie.

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CLINIQUE NEURO-CHIRURGICALE DE LA PITIÉ (PR. PETIT-DUTAILLIS), SECTION D'ÉLECTRO-NEURO-RADIOLOGIE, PARIS, FRANCE

TOMOGRAPHIE DE LA RÉGION PÉTRO-SPHÉNO-OCCIPITALE. INCIDENCE DES QUATRE DERNIÈRES PAIRES CRÂNIENNES

par

H. Fischgold, J. Metzger et *G. Korach*

Pour étudier les modifications radiographiques de la base du crâne dans les syndromes cliniques impliquant une atteinte des quatre dernières paires crâniennes (glosso-pharyngien, pneumogastrique, spinal et hypoglosse), la radiographie classique a mis au point des incidences spéciales:

— pour le *trou déchiré postérieur:*
l'intéressante incidence II de CHAUSSÉ (2) décrite en 1938 et la récente incidence trans-maxillaire de ROSSAND (6) qui donne le trou déchiré postérieur à travers la branche montante du maxillaire.

— pour le *canal condylien antérieur*, l'incidence d'ADELCHI SALOTTI (8) très voisine de l'incidence de STENVERS et celle de MIFKA (5) qui rappelle celle de BEAU, GALLY et GERARD (1).

Ce travail se propose de montrer l'intérêt de la tomographie pour apprécier une destruction osseuse de la base du crâne dans ses rapports avec le rocher, l'os occipital et le sphénoïde. Elle a pour but de préciser l'étendue et les limites de la lésion, vue dans l'ensemble de cette région si importante pour le neurologue et le neuro-chirurgien.

Technique tomographique

La tomographie de cette région a fait l'objet de 2 publications récentes: celle de LACHAPÈLE, HUMBERT et CHUPIN (4) et celle de HERDNER (3) dans son traité de tomographie osseuse.

Remis à la Réd. le 11 Janvier 1954.

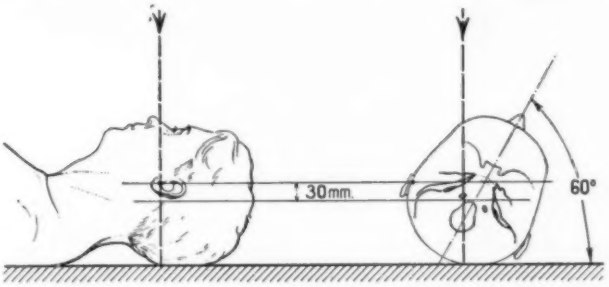
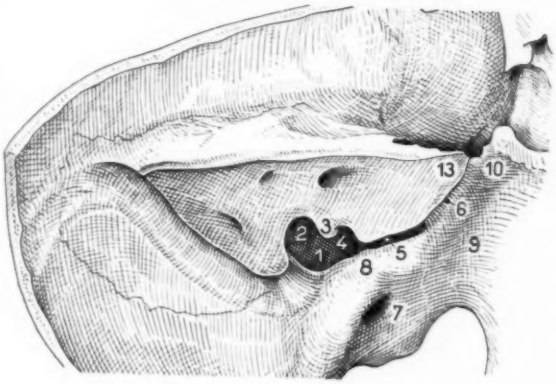


Fig. 1. Tomographie de la région pétro-sphéno-occipitale: position de la tête. Le trou déchiré postérieur et le canal condylien se trouvent sur les coupes pratiquées entre le plan supérieur (passant par le conduit auditif interne) et le plan inférieur (30 mm plus bas).

a.



b.

Fig. 2. Tomogramme étalon et schéma anatomique de la région.

1. Trou déchiré postérieur.
2. Fosse jugulaire.
3. Epine jugulaire du rocher.
4. Encoche pyramidale du rocher.
5. Défilé des nerfs IX, X et XI.
6. Suture pétro-occipitale.
7. Canal condylien antérieur (nerf XII).
8. Masse latérale de l'occipital.
9. Clivus.
10. Sphénoïde.
11. Mastoïde.
12. Labyrinthe osseux.
13. Pointe du rocher.
14. Masse latérale de l'atlas.
15. Apophyse odontoïde.

Dans les deux techniques précédentes, ainsi que dans celle que nous allons exposer, le principe est à peu près le même. Dans la nôtre le malade est placé en décubitus dorsal, le plan sagittal médian du crâne faisant avec le plan horizontal un angle de 60° ouvert du côté opposé à la région à radiographier. La ligne «bord inférieur de l'orbite-conduit auditif externe» du côté à radiographier est perpendiculaire au film (Fig. 1). On centre sur l'angle inféro-externe de l'orbite.

Le grand axe du rocher à examiner se trouve approximativement parallèle au plan horizontal, comme dans la position de STENVERS.

Les coupes sont pratiquées avec un angle d'ouverture d'environ 40°; le balayage est linéaire suivant l'axe longitudinal du corps.

Le trou déchiré postérieur et le tubercule occipital contenant dans sa profondeur le canal condylien antérieur, se trouvent dans une épaisseur limitée par 2 plans parallèles au film: le plan supérieur passe par le conduit auditif externe du côté examiné; le plan inférieur se situe 30 mm plus bas.

Selon la symptomatologie clinique, le radiologiste cherche à obtenir, dans les meilleures conditions de visibilité, les structures contenues dans la figure 2 que nous considérons comme l'image étalon.

Ces tomographies passent d'arrière en avant (ou de bas en haut) à travers une région comprenant le rebord du trou occipital, le condyle et le tubercule occipital avec dans son épaisseur, le canal condylien antérieur et le clivus; la gouttière du sinus latéral, le trou déchiré postérieur prolongé en avant par la suture pétro-occipitale; enfin la face postérieure et supérieure du rocher (Fig. 2).

L'ensemble de cette région peut être reconstituée grâce aux tomogrammes; dans des cas exceptionnels, une seule coupe tomographique donne en même temps la plupart de ces structures.

Il n'est pas nécessaire de mettre des chiffres de profondeur sur les plans de coupe; ce qui intéresse, c'est de retrouver les éléments plus haut énumérés, sur au moins une ou deux des quatre coupes.

La figure 2 montre le cas favorable d'un enfant de 10 ans, chez lequel un seul plan de coupe contient la plupart des détails intéressant de la région.

Observations

Pour montrer l'intérêt de cette incidence tomographique nous publions 4 observations.

Dans toutes les quatre, la lésion du trou déchiré postérieur a été mise en évidence par l'incidence II de CHAUSSÉ ou par celle de PORCHER, POROT et ROSSAND. Dans toutes les quatre, nous avons pratiqué des agrandissements $\times 2.2$, avec le tube à foyer fin de Van der Plaats

Fig. 3. Obs. 1. Neurinome du XII gauche.

a. Côté droit normal. (Mêmes symboles que dans la figure 2.) b. Côté gauche. La fosse jugulaire est agrandie dans toutes les directions aux dépens du rocher, de la masse latérale de l'occipital et du clivus; le défilé nerveux est intact. L'épine jugulaire et l'encoche pyramidale ont disparu. Un liséré de condensation délimite, par rapport aux os voisins, le pourtour de la lésion osseuse.

donnant des images très fines de structure. *Le diagnostic n'a donc été fait, dans aucun cas, par la tomographie.* Les images que nous publions montrent néanmoins l'intérêt qu'il y a pour le neuro-chirurgien d'avoir en plus du «diagnostic» proprement dit la région pétro-sphéno-occipitale libre de toute superposition gênante.

Voici nos quatre observations résumées:

Observation 1 (fig. 3 a et b). *Neurinome du XI (ou du XII) gauche.*

S... Eugène, 19 ans, début par une modification du timbre de la voix. A l'examen, 4 mois plus tard, on constate une atteinte du IX: chute du voile du palais à gauche

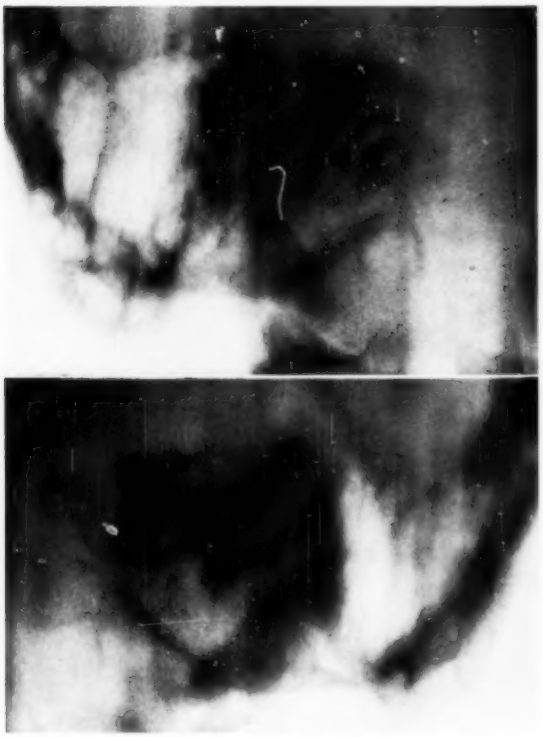


Fig. 4. Obs 2. Neurinome bilateral de l'acoustique.

a. Côté droit. Le neurinome parti du conduit auditif externe, creuse une cavité arrondie à limitation dense et irrégulière, détruit la portion inférieure du rocher et communique avec le trou déchiré postérieur. b. Côté gauche. Le neurinome détruit complètement toute la portion du rocher située entre le labyrinthe osseux et la pointe; il constitue une seule cavité avec le trou déchiré postérieur gauche qui est resté intact du côté de l'occipital. Les bords de cette vaste cavité sont déchiquetés mais nets.

avec aréflexie du même côté; du X: paralysie de la corde vocale gauche; du XI: atrophie musculaire importante du trapèze gauche; du XII: hémiatrophie linguale gauche.

A l'intervention: *neurinome du XI ou du XII gauches.*

Observation 2 (fig. 4 a et b). *Neurinome bilatéral de l'acoustique.*

L... Claude, 19 ans; début à l'âge de 15 ans par l'apparition d'une surdité bilatérale. A l'âge de 16 ans, ablation d'un neurinome dorsal. Le tableau se complète progressivement et, à 19 ans, le malade présente une atteinte du II: hémianopsie latérale homonyme droite; du III: strabisme inférieur à droite; du V: abolition du réflexe cornéen droit; du VII: paralysie faciale droite (par atteinte des nerfs supérieur et inférieur);

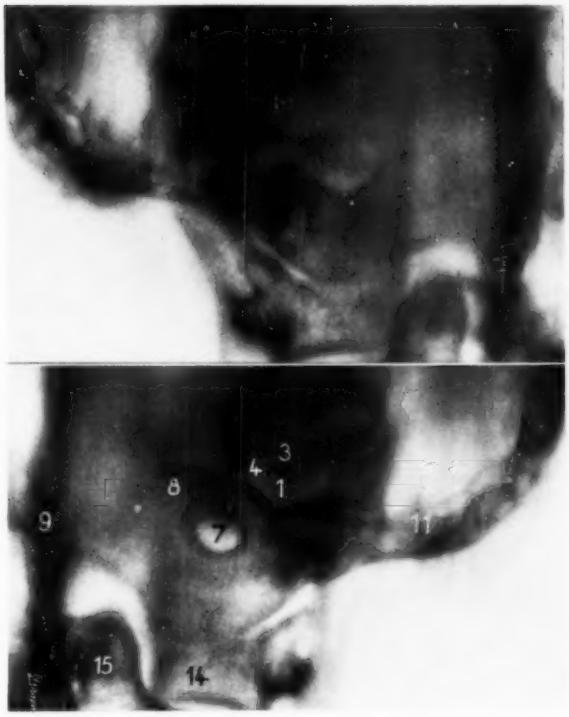


Fig. 5. Obs. 3. Métastase d'un cancer du sein.

a. Côté droit. Le trou déchiré postérieur a conservé son liséré sur le bord inférieur de la fosse jugulaire. Ses bords s'effacent sur les côtés du défilé nerveux. La lacune se développe sans limite précise dans le rocher et pénètre dans l'oreille interne. A comparer le bord estompé de la lacune dans ce cas avec les limites nettes de celles des figures 3 b, 4 a et b. b. Côté gauche normal. (Mêmes symboles que dans la figure 2.)

du VIII: surdité totale bilatérale; du IX et du X: hémiparésie avec hémianesthésie du voile à droite.

Tachycardie à 96. Paralysie des cordes vocales droites.

Observation 3 (fig. 5 a et b). *Métastase d'un cancer du sein dans la région du trou déchiré postérieur droit.*

B . . . 57 ans. A 52 ans, amputation du sein gauche; à 57 ans, apparition de céphalées, vertiges, vomissements, d'une diplopie et d'une surdité droite.

L'examen clinique montre une atteinte du IV: paralysie du grand oblique droit; du V: hypoesthésie cornéenne droite; du VIII: surdité droite importante de type labyrinthique; du IX: névralgie avec hypoesthésie et asymétrie du voile; du XI: atrophie du trapèze.

Fig. 6. Obs. 4. Métastase d'un cancer bronchique.

a. Côté droit. Vaste lacune osseuse ayant détruit tout le rebord du trou déchiré postérieur, le défilé nerveux, le clivus et la masse latérale de l'occipital. Bords estompés de la lacune, comme sur la figure 5 a. b. Côté gauche normal. (Mêmes symboles que dans la figure 2.)

Observation 4 (fig. 6 a—b, 7 a—b). *Métastase d'un cancer broncho-pulmonaire dans la région du trou déchiré postérieur droit.*

T... Robert, 51 ans; début par un épisode pulmonaire fébrile; 2 mois plus tard, le malade découvre une hémiatrophie linguale droite.

A l'examen, on constate une atteinte du IX: signe du rideau à droite; du X: voix assourdie; du XI: fossette sus-claviculaire moins marquée à droite, mais surtout du XII: hémiatrophie droite de la langue, avec fibrillations et déviation de la pointe vers la droite.

Radiographie et bronchoscopie: cancer broncho-pulmonaire droit.

Fig. 7. Obs. 4 (suite)

a. Côté droit. La masse latérale de l'occipital et le canal condylien antérieur sont remplacés par une vaste lacune limitée en bas par le rebord occipital et le condyle, en avant par le clivus. b. Côté gauche normal. (Mêmes symboles que dans la figure 2.

RÉSUMÉ

La tomographie de la région pétro-sphéno-occipitale est pratiquée en mettant la tête dans une position voisine de celle de Stenvers. Les auteurs décrivent l'anatomie tomographique de cette région. Les coupes tomographiques permettent de définir l'étendue et les limites de la lésion par rapport aux structures osseuses voisines; 4 cas pathologiques démontrent son intérêt: 2 neurinomes et 2 métastases.

SUMMARY

Tomography of the petro-spheno-occipital region is carried out with the head in a position approximating to that in Stenvers projection. The authors describe the tomographic anatomy of this region. The tomographic cuts enable the extent and the boundaries of the lesion in relation to the surrounding bony structures to be defined. Four illustrative cases, consisting of 2 neurinomas and 2 metastases, are presented.

ZUSAMMENFASSUNG

Das tomographische Schichtbild der petro-spheno-occipitalen Gegend wird ausgeführt in dem man den Kopf in eine der Stenvers'schen annähernden Lage bringt. Die tomographische Anatomie dieses Schädelteiles wird beschrieben. Schichtbilder ermöglichen die Weite und die Grenzen der Knochenzerstörung im Verhältnis der umgebenden Knochenelementen festzusetzen. Vier pathologische Fälle beweisen das Interesse dieser Untersuchungstechnik: 2 Neurinome und 2 Metastasen.

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THE EFFECT OF SOURCE SIZE UPON INTEGRAL DOSE IN TELETHERAPY UNITS

by

J. L. Haybittle

The maximum dose-rate available from a teletherapy unit at a given source—skin distance is determined by the specific activity and volume of the source. As the number of curies/g of active material is limited by the maximum neutron flux available for isotope production, it is important to know how large the physical dimensions of the source may be made before they impair the clinical efficiency of the unit. Because of self-absorption of the gamma rays in the active material, a source of greater total activity is better obtained by increasing its cross-sectional area than by increasing its length. This, however, introduces into the emergent beam an undesirable penumbra which has been discussed by BRUCER (1) in terms of the increased area of irradiated skin, and by GREEN et al. (5) in terms of the width of the penumbral region as measured on the skin. A further consequence of large source diameter and penumbra is to increase the integral dose received by the patient, and it is the purpose of this paper to assess the magnitude of this effect.

Theoretical

Let us consider the case of an area of radius a at a depth z in a phantom being irradiated by a circular source of radius s through a defining aperture of radius r distance d from the surface of the phantom (diagram 1). Let f be the source—skin distance. Providing equal numbers of photons cross the defining aperture and that all these photons are

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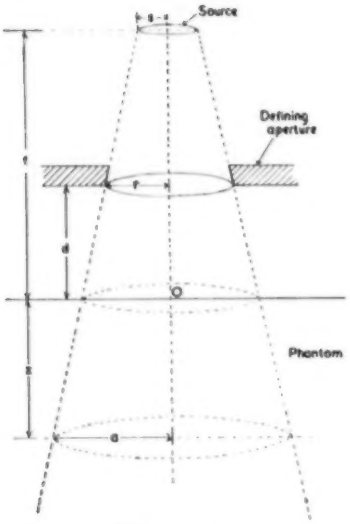

Diagram. 1.

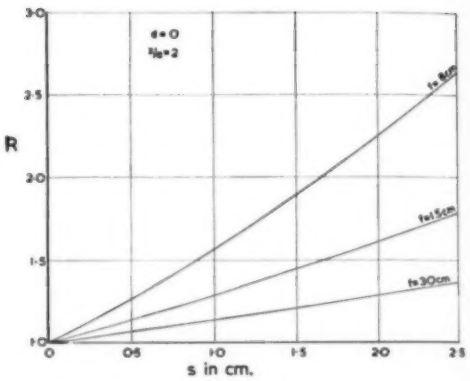

Diagram 2. Variation of R with source radius, s, for short-distance teletherapy units in the treatment of an area of radius a cm at a depth z cm, where z = 2 a. Aperture to skin distance = 0.

absorbed in an infinite phantom, then the integral dose, being a measure of energy absorption, is equal to the total energy of the photons entering the phantom and is independent of the size of the source. In any particular case the phantom will be of finite size. Also, as the shape of the isodose surfaces depends on the size of the source, the number of photons crossing the defining aperture for a given dose at the centre of the field, 0, will vary with the source size. The error introduced by ignoring these two factors is not likely to be large, as shown by the experiments described below.

We may therefore assume that the integral dose depends only upon the size of the defining aperture and is directly proportional to the area of that aperture, *i. e.* to r^2. In order that the whole of the area required to be treated may be able to 'see' the whole of the source, the radius of the defining aperture must be equal to:

$$r = s + \frac{f-d}{f+z}(a-s)$$

and

$$r = \frac{f-d}{f+z} \cdot a \text{ when } s = 0$$

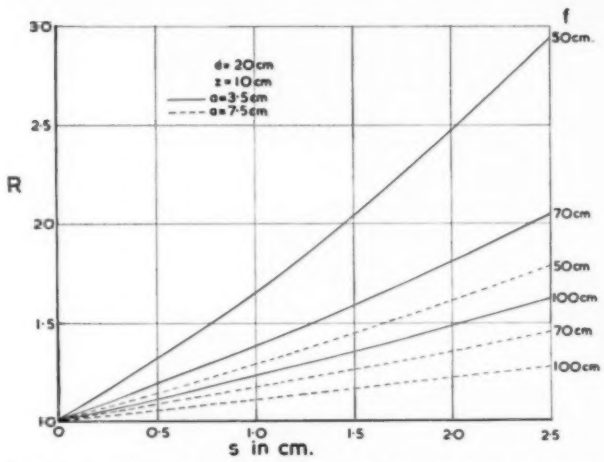

Diagram 3. Variation of R with source radius, s, for large teletherapy units in the treatment of areas at a depth z = 10 cm. Aperture to skin distance = 20 cm.

If we define R as the ratio of the integral dose received with a source of radius s to that received with a point source, for a given set of values of f, d, z and a, then:

$$R = \left\{ \frac{s + \frac{f-d}{f+z}(a-s)}{\frac{f-d}{f+z} \cdot a} \right\}^2 = \left\{ 1 + \frac{s}{a} \cdot \frac{z+d}{f-d} \right\}^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

For small values of a, R will become large, but on the other hand the integral dose is not likely to be of critical importance for small fields. The value of R for any given set of circumstances is easily calculated, and diagrams 2, 3 and 4 show how R varies with s in some cases of practical interest. Diagram 2 illustrates the effect of source-size in small teletherapy units using, say, radium, ^{192}Ir or ^{60}Co where the beam is defined by an aperture in contact with the skin (*i. e.* d = 0) and f varies between 8 and 30 cm. R then becomes $\left(1 + \frac{s \cdot z}{a \cdot f}\right)^2$, and the particular case chosen for diagram 2 is where $\frac{z}{a} = 2$, *i. e.* the treatment of a 5 cm circle at 5 cm depth or a 10 cm circle at 10 cm depth, etc.

Diagram 3 shows the effect of source-size in large teletherapy units working at S. S. D's from 50 to 100 cm with defining apertures 20 cm

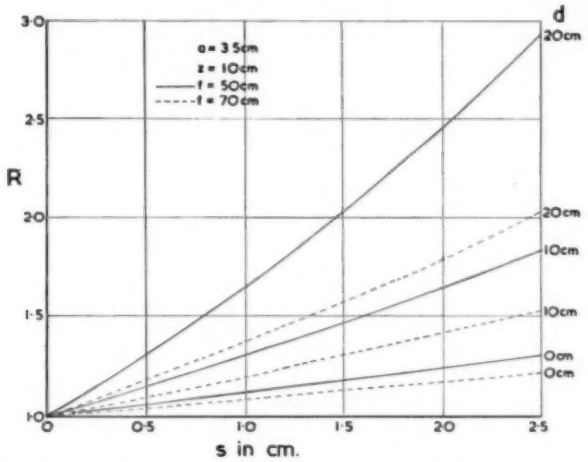

Diagram 4. Variation of R with source radius, s, for different values of aperture—skin distance, d, in the treatment of a 7 cm diameter circle at a depth of 10 cm.

from the skin. Curves are shown for treatment areas of 7 and 15 cm diam. at a depth of 10 cm.

Diagram 4 demonstrates the marked influence of the distance from aperture to skin upon R with S. S. D's of 50 and 70 cm. The treatment area in this case is a 7 cm circle at a depth of 10 cm.

Experimental

As a first step in testing the validity of equation (1) when applied to finite phantoms, a full analysis was made using graphical integration in the extreme case of a large source treating an area of equal size to itself at a relatively short S. S. D. with a defining aperture half-way between the source and the skin. The actual values of the parameters were: $s = a = 2.5$ cm, $f = 2d = 16$ cm, and $z = 7.5$ cm in a phantom of total depth 15 cm. The contribution to the integral dose due to scattered radiation was calculated by the method of MEREDITH and NEARY (9), and the absorption of the primary beam allowed for using an absorption coefficient of 0.106 cm^{-1}. This corresponds to iridium 192 gamma rays of mean energy 400 keV, the lowest likely to be used in a teletherapy unit. As a result the value of R was found to differ by only 4 per cent from that obtained using equation (1).

These calculations assume a phantom of infinite dimensions perpendicular to the direction of the beam. In practice the smaller teletherapy units are mostly used in treatment of the head and neck, and

it therefore seemed worth while to make some actual measurements of the integral dose delivered by a teletherapy unit when irradiating a phantom of dimensions approximating to those of a patient's head. Measurements have been made using an ^{192}Ir teletherapy unit (4) to irradiate a perspex tank 15 × 15 × 15 cm. The tank was filled with a 10^{-3} molar solution of ferrous sulphate in 0.1 N sulphuric acid and the yield of ferric ion estimated by direct spectrophotometry. This chemical method of dosimetry has been fully described by MILLER and WILKINSON (11), and a G value of 20 molecules/100eV absorbed was used to calculate the integral dose in g r in the solution.

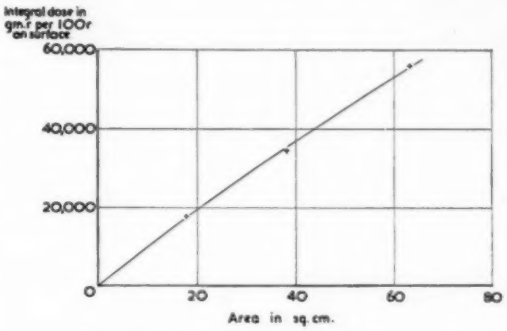

Diagram 5. Experimental variation of integral dose with area of field when the defining aperture is in contact with the phantom at an S. S. D. of 13 cm.

In the first experiment a special source container was made for the iridium unit to contain only a sixth of the normal source in a volume of cross-sectional area 5 × 9 mm. This small source was then used to irradiate the tank through a 7 cm diameter field at 9 cm S. S. D. The integral dose was found to be 34,600 g r per 100 r on the surface. When the unit was used with the full source to irradiate the tank under the same conditions the measured integral dose was 36,000 g r per 100 r on the surface. As the full source is 3 cm in diameter, these two results provide justification for the assumption that for a given aperture the integral dose is independent of source size.

Diagram 5 shows the measured variation of integral dose with area using the full source at 13 cm S. S. D. The relationship is almost linear, the departure from linearity at larger areas being accounted for by the greater proportion of the incident radiation being scattered outside the lateral walls of the tank.

Finally a measurement was made with the full source and an S. S. D. of 13 cm but using a lead defining aperture 4.8 cm in diameter placed 9 cm from the source. This gave a field 5.6 cm in diameter on the surface of the tank, and equation (1) above predicts that the integral dose is 1.53 times that delivered with a defining aperture in contact with the surface. The experimental result was an integral dose of 33,900 g r per 100 r on surface, which is 1.47 times the value obtained from diagram 5 for a 5.6 cm diameter field.

The extremely satisfactory agreement between experiment and theory in these measurements shows that in most practical cases equation (1) may be used to calculate to within a few per cent. the effect of source size upon integral dose.

Discussion

When trying to assess the clinical significance of the curves shown in diagrams 2, 3 and 4, it has to be remembered that point sources of radiation have never been available for radiotherapy. In the absence of more definite data on the effects of integral dose, it is perhaps of most interest in the first place to see how the integral dose per r at the tumour delivered by teletherapy units compares with that delivered by conventional 200—250 kVp roentgen apparatus. We have found on the deep therapy sets used in this department that the focal spots are anything up to 1.5 cm in diameter. The usual type of applicator at 50 cm F. S. D. has a perspex end with a final limiting diaphragm about 6 cm from the skin. For the treatment of a 7 cm circle at a depth of 10 cm, a focal spot 1.5 cm diameter gives a value of R equal to 1.16. In making comparison with teletherapy units we must also take into account the different depth doses obtained. For a given set of conditions the following procedure may be adopted. Using published data on depth doses and backscatter the integral dose per 100 r on the skin is calculated by the method of MEREDITH and NEARY (9) for the roentgen set and the teletherapy unit assuming point sources in both cases. These are then converted to integral doses per 100 r at the tumor, and the value for the roentgen set is multiplied by the appropriate value of R. One can then obtain a value of R for the teletherapy unit that will give the same integral dose as the roentgen set, and hence obtain a permissible value of source radius, s_p. This procedure has been used to obtain the values shown in Table 1,

Table 1

Source of radiation	S. S. D. (cm)	Distance from aperture to skin (cm)	s_p
^{60}Co	100	20	6.4
»	50	20	2.25
^{137}Cs	100	20	5.7
»	50	20	1.8
»	50	10	3.7
^{192}Ir	9	0	1.0
»	13	0	1.7
Ra	8	0	1.1

where the treatment area is 7 cm in diameter at a depth of 10 cm in a phantom of total thickness 20 cm. Use has been made of the Central

Axis Depth Dose Data (2) assuming h. v. l's of 12, 10, and 8 mm Cu for the gamma rays of radium, ^{137}Cs and ^{192}Ir respectively. Backscatter figures for these were obtained from the table given by MAYNEORD and LAMERTON (8), while the backscatter data of DIXON et al. (3) was used for the ^{60}Co calculations. Comparison is made in the table with roentgen rays of h. v. l. 1.5 mm Cu and F. S. D. 50 cm.

Table 2 shows values of s_p for small units with short S. S. D.'s treating a 6 cm diameter area 6 cm deep in a phantom 12 cm deep.

Table 2

Source of radiation	S. S. D. (cm)	s_p
^{192}Ir	9	0.9
»	13	1.6
Ra	8	1.2
^{60}Co	20	4.1

Table 3 lists the values of S. S. D., aperture—skin distance and source radius, s, used in a number of existing teletherapy units.

Table 3

Source of radiation	S. S. D. (cm)	Distance from aperture to skin (cm)	s (cm)	References
^{192}Ir	9.13	0	1.5	FREUNDLICH & HAYBITTLE (4)
Ra	8.3	0	2.5	GRIMMETT (6)
^{60}Co	8.0	0	2.0	MEREWETHER *et al.* (10)
»	20	0	2.0	SPIERS (13)
»	50—100	20	1.3	JOHNS *et al.* (7)
»	70	40	2.0	NEIL *et al.* (12)

It is evident from the tables that the large cobalt 60 units with source diameters less than 3 cm deliver integral doses per r at the tumour less than those delivered by conventional roentgen apparatus. An exception is the Los Angeles unit (12), where the source is a cylinder 4.33 cm high by 3.5 cm diameter and a side view of the cylinder is presented to the treatment cone. It also appears that although the walls of the treatment cones may play a small part in limiting the beam, the main lead defining aperture is 40 cm from the skin when the S. S. D. is 70 cm. If we take 2.0 cm as a representative value of s, then in the treatment of a 7 cm diameter area at a depth of 10 cm in a phantom 20 cm thick, the integral dose will be about 40 % higher than that delivered by roentgen rays of h. v. l. 1.5 mm Cu.

Most of the small short-distance units using radium, ^{192}Ir or ^{60}Co also deliver higher integral doses than do 200—250 kVp roentgen rays. For example the ^{192}Ir unit used in this department delivers an integral dose 25 % higher when used at 9 cm S. S. D. in the treatment of a 6 cm circle at 6 cm deep in a phantom of total depth 12 cm, but a few per cent less when used at 13 cm S. S. D. The radium unit quoted in Table 3 would deliver an integral dose 53 % higher than roentgen rays of h. v. l. 1.5 mm Cu in the same conditions, while the similar unit modified by SPIERS (13) to use ^{60}Co at 20 cm S. S. D. would give an integral dose 28 % lower.

In the proposed teletherapy units using ^{137}Cs, it is likely that the source size will be larger than in present ^{60}Co units. For example, BRUCER (1) has estimated that a 9,700 curie source of ^{137}Cs giving an output of 20 r/min at 1 metre (comparable with the output of the Saskatchewan ^{60}Co unit), will have to be 10 cm long and 4 cm in diameter. From Table 1 it can be seen that at 50 cm S. S. D. with the defining aperture 20 cm from the skin such a unit would deliver a larger integral dose than would conventional roentgen apparatus. This could easily be reduced by bringing the aperture nearer to the skin, as demonstrated by the curves of diagram 4. For use at larger S. S. D.'s sources of up to 5 cm diameter as proposed by GREEN *et al.* (5) are well within tolerable limits.

In general it would appear that source-size in large teletherapy units need not increase the integral dose delivered to a patient above the levels that have been tolerated in the past. If, however, it is felt desirable to reduce considerably the integral dose below these levels, then the most effective method is to reduce the distance, d, from the defining aperture to the skin. The curve published by GREEN *et al.* (5) of relative surface ionisation against d, shows that for ^{60}Co this could be made as low as 10 cm with scarcely any appreciable increase in skin dose.

Acknowledgements

The author wishes to thank Dr A. J. SWALLOW for his assistance with the chemical dosimetry experiments, and Professor J. S. MITCHELL for his help and advice throughout.

SUMMARY

A simple formula is deduced on theoretical grounds for calculating the effect of source size upon integral dose in teletherapy units. Measurements of integral dose using the ferrous sulphate system of chemical dosimetry have been made and confirm the theoretical predictions. Particular attention is drawn to the critical influence upon integral dose of the distance from the skin to the defining aperture. Providing that this distance is not too large calculations of the integral dose delivered by a number of teletherapy units as compared with that delivered by 200—250 kVp roentgen equipment show that the source-size in large teletherapy units need not increase integral doses above the levels that have been tolerated in the past.

ZUSAMMENFASSUNG

Eine einfache Formel zur Berechnung des Effektes der Quellengrösse auf die Integraldosis bei Teletherapieanlagen wird theoretisch abgeleitet. Messungen der Integraldosis unter Benutzung des Eisensulphatsystemes der chemischen Dosimetrie sind ausgeführt worden und bestätigen die theoretischen Voraussagungen. Besondere Aufmerksamkeit wird auf den kritischen Einfluss des Abstandes von der Haut zur begrenzten Öffnung auf die Integraldosis gerichtet. Vorgesetzt, dass dieser Abstand nicht zu gross ist, zeigen Berechnungen der Integraldosis, die von einer Anzahl von Teletherapieeinheiten im Vergleich mit 200—250 KV Röntgenmaschinen geliefert werden, dass die Quellengrösse bei grossen Teletherapieanlagen die Integraldosis nicht über die Grenzen zu steigern braucht, die bisher toleriert worden sind.

RÉSUMÉ

Partant de données théoriques, l'auteur a établi une formule simple qui permet de calculer l'effet des dimensions de la source sur la dose intégrale émise par des appareils de télécuriethérapie. Des mesures de dose intégrale effectuées par la méthode de dosimétrie chimique par le sulfate ferreux confirment les prévisions théoriques. L'attention est particulièrement attirée sur l'influence déterminante sur la dose intégrale de la distance à la peau de l'ouverture qui limite le champ.

A condition que cette distance ne soit pas trop grande, les calculs de la dose intégrale émise par un certain nombre d'appareils de télécuriethérapie, comparée à celle qui est émise par un appareil de téléroentgenthérapie à 200—250 kVp, montrent que les dimensions de la source n'entraînent pas nécessairement une augmentation de la dose intégrale au-dessus des taux qui ont été tolérés jusqu'à maintenant.

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ON INCONSISTENCIES BETWEEN RADIOHEMATOLOGIC OBSERVATIONS

by

Matts Helde and *T. Wahlberg*

The elucidation of the connexion between physically determined irradiation conditions and changes in the blood picture constitutes an important problem in radiation protection work.

However, different authors' observations on this problem, all of which are to be looked upon as reliable, have given rise to contradictory results. The following point of view seems to be a possible explanation of these discrepancies.

If the blood changes observed are not caused by irradiation, the correlation between them and radiation doses found in several instances must be due to chance. But again, if the changes are caused by irradiation, the lack of correlation also found in several instances may be said to be due to chance. As an approximation authors often have taken account of one characteristic of the irradiation conditions but neglected others, the variations of which give the impression of lacking correlation when an attempt is made to show the relation between the blood changes and only one characteristic. Let us suppose that the changes are caused by irradiation and may therefore be referred to irradiation conditions. In radiation protection calculations those conditions usually are simply defined by the dose obtained during a more or less arbitrarily stated period, usually a week or a day. This simplification seems to be so rough an approximation that only exceptionally may we presume an obvious connexion between blood changes and such irradiation data.

However, there is reason to assume that systematic investigations may reveal the existence of a time unit more suitable than those usually chosen by virtue of its giving a better correlation.

Submitted for publication, Jan. 7, 1954.

A general statement

Supposing constant irradiation conditions, let us write:

τ = the most suitable time unit
T = an arbitrarily chosen time unit
D_τ = the irradiation dose per τ
D_T = » » » » T
B = the blood change frequency, here postulated to be a monotonously increasing function, $\varphi(D_\tau)$, of D_τ. For the sake of simplicity the function $\varphi(D_\tau)$ is assumed to determine B exactly. If, as the observations to be reported suggest, the most suitable time unit τ is very short and if the periods of exposure in actual work are longer than this, D_τ is equal to $\tau \times$ the dosage rate during exposure if the time interval τ selected falls in one of the exposure periods. For those time intervals τ which do *not* fall into an exposure, D_τ is zero. The assumption we are going to test is that the blood changes are best correlated to the values of D_τ during actual exposures and not to an average value of D_τ over longer periods.

If we try to establish the correlation using a less suitable time unit T ($T \geqq \tau$), we find that for the same value of D_T, the dose D_τ may, depending on the conditions of work, vary between the limits D_T (if the irradiation is given as one exposure equal to or shorter than τ for each time interval T) and $\frac{\tau}{T} D_T$ (for constant continuous irradiation during intervals not shorter than either τ or T). It follows that:

i) one and the same blood change frequency may be present at any D_T-value between D_τ and $\frac{T}{\tau} D_\tau$;

ii) B as a function of D_T may vary between the extreme values $\varphi(D_T)$ and $\varphi\left(\frac{\tau}{T} D_T\right)$.

Consequently, between these limits we have a space on which we shall find the observations scattered, and outside which no observation points can exist. If we use a very poorly suited time unit, this space may be so large that the scattering of the observations may give an impression of a random distribution.

In some cases, the maximum variation may be between different limits than those given above. If, for example, $T > \tau$ and $T > t$ (t = the maximum real irradiation time during T), the original extremes of D_τ ought to be replaced by D_T and $\frac{\tau}{t} D_T$.

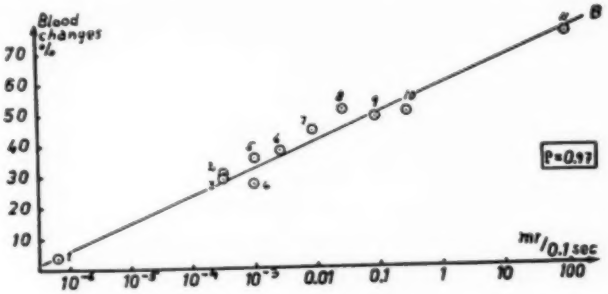

Diagram 1.

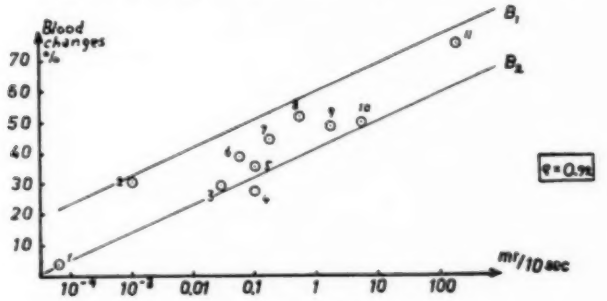

Diagram 2.

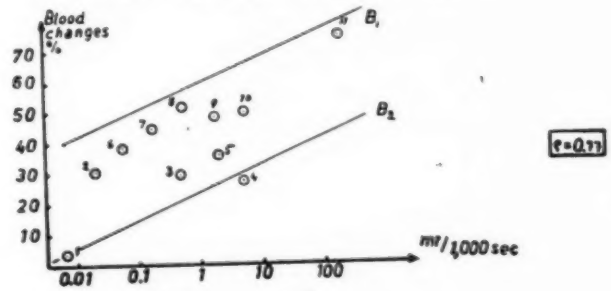

Diagram 3.

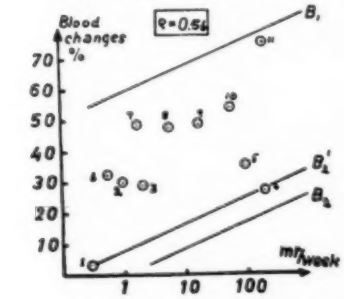

Diagram 4.

In all the diagrams the natural radiation is excluded.

An application

The results in a recent paper (1) may be used to illustrate the above manner of looking at the matter. Blood changes versus irradiation were studied in eleven groups (1—11 in the diagrams) of persons in roentgen work. (As a blood change is registered a blood investigation in which any of the following changes were found: Leukocytopenia $< 4{,}000$; shift to the left, ratio rod forms/segm. neutrophils $\geqq 0.15$; relative lymphocytosis $\geqq 45$ %; pathologic lymphocytes; or hypersegmented neutrophils). Four time units, T, were tested: a week (= 604,800 secs), 1,000 secs, 10 secs and 0.1 sec. When using the time unit $T = 0.1$ sec. the connexion between the blood change frequency, B, as a percentage, and the time dose, D_T, was expressed with surprisingly good accuracy (correlation coefficient, $\varrho = 0.97$) by the straight line

$$B = 8.3\ {}^{10}\log \frac{D_{T\,=\,0.1\ sec.}}{C} \quad (C = \text{a constant})$$

in a semi-logarithmic diagram. See diagram 1.

Consequently, in this case φ is a log-function and τ is an unexpectedly low time unit which because of the result cannot be essentially greater than something about 0.1 sec. (The material in view does not allow a final conclusion about its value. A method for its determining will be suggested below.)

When using the other time units, B as a function of D_T varied within a space well defined by the parallel limit lines

$$B_1 = 8.3\ {}^{10}\log \frac{D_T}{C} \text{ and } B_2 = 8.3\ {}^{10}\log \frac{0.1}{T} \cdot \frac{D_T}{C}\ ;\ \text{See ii) above.}$$

In the diagrams 2—4, the lines B_1 and B_2 are drawn. In diagram 4, an additional line B_2' is drawn, illustrating the case $T > t$, when the real irradiation time, t, during a week is a maximum of 50,000 secs. This is the case in the material in view.

To the time units 10 secs, 1,000 secs and a week correspond the correlation coefficients, ϱ 0.92, 0,77 and 0.56, respectively.

From the discussion above we see that the observations will be found 'at random', yet between or upon the lines B_1 and B_2, determined by τ and T, or t.

At one establishment or several establishments with uniform irradiation conditions for several workers it is possible to obtain real correlations between blood changes and time doses at arbitrarily chosen time units. But, we must observe the distinction between the correlation being *real*, and being 'universally' applicable. At other establishments with different irradiation conditions, we shall not find the same correlations when using the same or other, not most suitable, time units. Indeed, in certain

cases negative correlations may occur. The probability of such accidents obviously will increase with an increasing distance between B_1 and B_2, and decrease with an increasing variation space of the time dose, D_T. This fact may be demonstrated by diagram 3, if we postulate such irradiation conditions that the observations would have been grouped *e. g.* along the line through the points 4, 5 and 8.

Some consequences

1) When postulating a homogeneously distributed observation material in the parallelograms bounded by the lines B_1 and B_2 and the verticals passing through the two utmost observation points, with the lowest and highest time doses in the diagrams 2, 3 and 4 (with the time units 10 secs, 1,000 secs and a week respectively) we get theoretically calculated correlation coefficients of the values 0.96, 0.75, and 0.52. These correlations agree fairly well with the corresponding factors, ϱ, of the practical material. Though this practical material included only eleven observation groups, it may be looked upon as a fairly representative one.

2) If a time unit (T) different from the most suitable one (τ), is chosen, the observations will be found between or upon the lines B_1 and B_2. If such particular irradiation conditions are in hand that the observations at the highest T-value ($> \tau$) chosen lie *upon* B_1 and B_2 this obviously must be valid at *every* T-value $> \tau$; and correspondingly at T-values $< \tau$.

This fact can be made use of for a rational determination (or, at least enclosing) of τ, when the irradiation conditions can be chosen at will (*e. g.* in animal experiments). The irradiation conditions should then be chosen in such a way that the observations which will fall upon the upper (lower) line at T-values $> \tau$, at T-values $< \tau$ will fall upon the lower (respectively upper) line.

3) The position of a person or a uniformly irradiated group of persons within the 'region of existence' between the lines B_1 and B_2 is not determined with regard to the blood change frequency (or probability) unless the dose for periods close to the most fitted time, τ, is determined. The more the T-value varies from τ, the more undefined is the position of the observation in the region.

But, if the region is filled up by observations, the fact that these are strictly limited by lines determined by the irradiation conditions gives rise to a 'law' with a statistical consequence, which may be expressed by a correlation factor: this is dependable for a large number of persons but of little interest for the individual who does not trust to chance to escape injury.

Acknowledgement

The authors are indebted to Dr. Sven Benner for his valuable support and advice on the presentation of our results.

SUMMARY

On the assumption that irradiation blood changes are mainly determined by the irradiation dose obtained during a certain (most suitable) time unit, it is shown what the connexion between blood changes and irradiation can be expected to be when using other reference time units. When this unit is not employed, the connexion is undefined within certain limits. The greater the divergence from the most suitable time unit, the more undefined the connexion.

An observation material analyzed in a former paper (1) is in accordance with the point of view here developed, when the most suitable time unit is postulated as being very short (about 0.1 sec.). This also seems to offer an explanation of the several reliable but mutually contradictory studies on the relation between blood changes and irradiation.

ZUSAMMENFASSUNG

Unter der Voraussetzung, dass durch Bestrahlung hervorgerufene Blutveränderungen hauptsächlich durch die während einer gewissen (günstigsten) Zeiteinheit erhaltene Strahlendosis bestimmt werden, wird gezeigt, welche Beziehungen zwischen Blutveränderungen und Bestrahlung erwartet werden können, wenn man andere Zeiteinheiten benutzt. Wird die günstigste Zeiteinheit nicht benutzt, ist die Beziehung innerhalb gewisser Grenzen unsicher. Je grösser die Abweichung von der günstigsten Zeiteinheit ist, umso unsicherer wird die Beziehung.

Ein Untersuchungsmaterial, das früher (1) bereits analysiert worden ist, stimmt mit den hier ausgeführten Gesichtspunkten überein, wenn man voraussetzt, dass die günstigste Zeiteinheit sehr kurz ist (etwa 0.1 Sek.). Dies scheint auch eine Erklärung von manchen Widersprüchen verschiedener Studien über Blutveränderungen und Bestrahlung zu bieten.

RÉSUMÉ

Admettant que les modifications sanguines dues aux radiations dépendent principalement de la dose de rayonnement reçue au cours d'une certaine unité de temps (la plus adéquate), les auteurs montrent quelle corrélation on peut s'attendre à trouver entre les modifications sanguines et la dose de rayonnement quand on adopte d'autres unités de temps. Quand on n'emploie pas cette unité, la corrélation est indéterminée entre certaines limites. Plus on s'écarte de l'unité la plus adéquate, plus la corrélation est indéterminée.

Une série d'observations analysées dans un précédent article (1) est en accord avec le point de vue exposé ici, quand on suppose que l'unité de temps la plus adéquate est très courte (environ 0.1 sec.). Ceci semble aussi expliquer les contradictions entre plusieurs travaux dignes de confiance sur la relation entre les modifications sanguines et la dose de rayonnement reçue.

REFERENCE

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BOOK REVIEWS

THE DIGESTIVE TRACT IN ROENTGENOLOGY, Vol. I & II, 2nd Edition. By Jacob Buckstein. 1,202 pp. 1,534 illust. J. B. Lippincott Company, Philadelphia, Pa., 1953. $ 30.—.

The author is radiologist at the Gastro-intestinal Division of Bellevue Hospital, New York and several other institutions. His book is based upon more than thirty years' experience and a comprehensive and detailed study of the literature.

The author states in the preface that the material which has been used has been followed up at operation or autopsy with special regard to the pathologico-anatomic diagnosis and the roentgenologically apparent changes in shape. Furthermore, he has sought to select such material which has appeared to possess didactic value, both from the clinical and roentgenologic viewpoints. The reader will also quickly gather that both the descriptive text and the illustrative case records rest upon pathologico-anatomic foundations. He will also find that the author seriously endeavours to follow the development in the literature and this is especially true of its earlier period and far back in the pre-roentgenologic epoch. Publications on clinical aspects and pathology more than a century old are referred to in detail and often with moving reverence. Consideration has been given to the earlier roentgenologic literature with the same thoroughness and those portions not in the English language have also received due attention. Contributors of the special articles in our journals may now and again have to revise their views on the precedence of certain experiences from a study of BUCKSTEIN's information concerning the literature. On the other hand, one finds, that some important papers in the roentgenologic literature of the last decade has been omitted. The impression on the whole is, however, that the author has laid his work on solid ground. The presentation is to a large extent correct, clear and readable. The arrangement follows the customary division into organs and each is grouped pathologico-anatomically. The clarity of the arrangement is, however, obscured by a somewhat inconsequent division of the chapters. Detailed information is easy to find by reason of an exhaustive index of items. In addition, there is a bibliographic index.

The descriptive text furnishes a survey of the development of our knowledge of the patho-anatomy and clinical aspects of every disease, and in which, in the reviewer's opinion much unnecessary space is taken up with details purely of historical interest. The very thorough presentation of the macroscopic pathology which follows is the backbone of the book and its most meritorious section. The presentation of roentgen technique and roentgen diagnosis which follows is on the other hand somewhat summary. It is routine and standard techniques and their results which are mainly discussed. Those technical details which often make a more comprehensive and polished diagnosis possible, are dealt with more parsimoniously. High voltage technique with hard-penetrated films, diluted contrast media, gas insufflation and true lateral views do not receive adequate valuation; the significance of the position of the body in contrast media investigations is also not satisfactorily analysed and exploited.

The very comprehensive picture material also bears witness that modern roentgen technique has not been employed. The contrast is often too great and permits only of studies of contour, and sometimes when an overlying part has not been penetrated even that is not possible. The films throughout consist of negative copies with all-white contrast and often with unsatisfactory sharpness of outline. A comparison with, say, the

work of SCHINZ-BAENSCH-FRIEDL convinces one that BUCKSTEIN's book, both as regards roentgen technique and the illustrations, does not lie at the highest level.

For every disease, a complete and fully illustrated case record with an account of the history, clinical data and result of the roentgenologic and pathologico-anatomic investigations is added to the descriptive text. The reader in this way obtains a repetition of the description in the text in the form of several examples to assist his memory and which, at least for the less experienced, may make the study more profitable.

The work, in the opinion of the reviewer, not fulfilling modern demands as regards roentgen technique and illustrative standards, has a considerably lessened value as a text book. It has, however, unquestionable merit as a reference book for the practising radiologist who may obtain guidance in cases either uncommon or difficult to interpret and in which another text book might be consulted in vain.

W. Magnusson.

GRENZEN DES NORMALEN UND ANFÄNGE DES PATHOLOGISCHEN IM RÖNTGENBILDE DES SKELETTES. Von A. Köhler †. 9. Auflage von E. A. Zimmer, Georg Thieme Verlag, Stuttgart 1953, 672 Seiten, 1,282 Abb. DM 88.—.

All the thousand and one variations and anomalies, particularly in the diagnostics of the bony skeleton, which can be so difficult to differentiate from pathologic processes or traumatic injuries, can never be kept fresh in the mind. 'Köhler's Grenzen' has thus for forty years constituted a store-house from which immediate information of increasing value and completeness from edition to edition could be withdrawn.

After KÖHLER's death, the last edition of his work had to become ten years old before it could appear in new guise. The publishers selected E. A. ZIMMER of Berne to don the fallen cloak and one realizes from the beginning that no happier choice could have been made. ZIMMER has himself produced recognized works in the field concerned. Among other things, he has developed and completed our somewhat sketchy knowledge, gathered from PFITZNER, of the supernumerary centres of ossification, particularly of the carpus and the tarsus. He has obviously had access to comprehensive and well-organized roentgenographic archives.

The first part of KÖHLER's book, the portion dealing with the skeleton, was certainly the one of which the most use was made, and ZIMMER restricted the subject-matter in a masterly way when he deleted all the remainder which appeared in the earlier editions. He has maintained the character of the work as a reference book and subjected it to thorough modernisation. His knowledge of the literature is entirely up-to-date and includes to a surprising extent those years when, by reason of the second world war, the reference periodicals fell off and the Cumulative Book Index became incomplete. This surveying of unchartered lands in scientific roentgenologic production must have been an enormous task and merits the thanks of all radiologists. The work enables us to obtain fully up-to-date references to research in all branches of the roentgenology of the skeleton. At the same time, the new edition has become many times more valuable for our daily diagnostic routine. And as it is published in the languages of the three leading cultures, it may be said to be the property of radiologists the whole world over.

The illustrative material demands special consideration. A large number of the old blocks had, through eight editions, become worn out and ZIMMER has given us as good as a completely new picture material, behind which lie recent improvements in roentgen technique, such as direct enlargement by means of a fine focus. ALBAN KÖHLER's own films of the diseases named after him have been reverently retained. The publishers

have manifestly expended great care on the reproductions and the result lies at a very high level.

It is obvious that it lies outside the bounds of human endeavour to make a work of this kind complete in every way. The reviewer would in no sense desire to draw up a list of deficiencies but would venture to put forward certain desirata for future editions.

On the question of soft tissue technique one would rather have liked to have seen a reference to FRANTZELL's work; in the discussion on the soft parts of the neck, the adenoids and the epipharyngeal tumours are missing. Arthrosis of the temporo-mandibular joint is fairly completely dealt with although there is no reference to the differential diagnosis of otalgia as a consequence of lowering of the bite and arthrosis of the temporo-mandibular joint.

In the discussion on the isometric rule of CIEZYNSKI, HERULF's investigation upon the distortion in the projection of the teeth deserves to have been mentioned. The bone changes associated with meningeomata are so practically important that they might have been both described and illustrated. Discography is referred to entirely as ERLACHER's contribution; LINDBLOM's transdural puncture is, without doubt, the more valuable method (and certainly should have priority). Unco-vertebral arthrosis and 'cervical migraine' are relatively fully described, but disc degenerations in the lower cervical region with spondylosis and the sequelae of brachialgia and cardialgia are of sufficient practical importance to warrant mention. WALDENSTRÖM's work on the first stages of coxa plana has greater practical worth and indisputable priority over that of the authors mentioned. Rickets is treated grudgingly and inadequately illustrated.

That a number of proof errors are encountered in a book of this scale is naturally unavoidable. Still it is desirable that the name of an author should be given correctly.

Small blemishes can in no way detract, however, from the value of ZIMMER's prototype re-styling of the principal roentgenologic reference book. One must hope that the arranger will be able to revise his work through many editions. For this is a book without which no one can pursue satisfactory roentgen diagnostic practice.

S. Ribbing

SELECTED PAPERS FROM THE INSTITUTE OF CANCER RESEARCH, ROYAL CANCER HOSPITAL AND FROM THE ROYAL CANCER HOSPITAL. Vol. 7, 1950—1951, 643 pp.

The present collection embraces some eighty works upon radiotherapy, radiophysics, radiobiology, tumour pathology and general cancer research. The majority of the articles are of a special nature and should already be well known to research workers in the respective subjects. Only a résumé of the contents and viewpoints in the articles of more general interest can be given in this survey.

In an article by BROOKS et al. on Carcinoma of the Bronchus (Thorax 6 (1951), 1) 502 cases of bronchial cancer which were treated by roentgen rays are analysed. Most of the cases were inoperable. One hundred and seventy-six patients received palliative roentgen therapy. Radical roentgen treatment (> 4,000 r to the tumour) was given to 129 patients. In the latter group, the absolute survival after 2 years was 15.5 % and after 5 years 5.9 %.

Chemotherapy was tried in some cases. Improvement was noted in a number of patients treated with chlorethylamines but the improvement was transient.

It is of the utmost significance in the analysis of large materials of bronchial cancer treated with non-surgical methods that the majority of the cases are not operable when they come for diagnosis. According to the article, about 9,000 people die of bronchial cancer every year in England and Wales and "probably fewer than 200 have a pneumonectomy performed".

In *Androgen therapy in 70 cases of advanced mammary carcinoma* (Brit. J. Cancer 4 (1950), 20) Galton gives a good survey of the literature relating to surgical castration, roentgen irradiation of the ovaries and androgen therapy in inoperable or advanced recurrent mammary carcinoma. Relief of pain was obtained in about 50 % of cases with bone metastases; in 20 % of cases, "substantial remission" was recorded. If there is no response from hormone treatment within two months it is useless to continue.

It appears as if useful remissions occur in 20 % of cases whether these are treated with androgens, surgical castration or roentgen irradiation of the ovaries. This is worth bearing in mind when the effect of adrenalectomy in cancer of the breast is discussed. In such cases oophorectomy is of course generally performed at the same time.

In the article *Cancer of the mouth*, (Brit. J. Cancer 4 (1950), 6), LEDLIE and HARMER state that they obtained statistically better results with teleradium than with roentgen (high and medium voltage) in cases of buccal, sublingual, gingival and hard palate cancer. Block dissection was carried out only in 41 cases. Prophylatic block dissections have been given up.

MAYNEORD's article *Some problems of radiation protection* (Brit. J. Rad. 24 (1951), 525) constitutes a further valuable contribution in this important sphere.

Interesting investigations have been carried out by DEVIK et al. (The influence of diet on the Walker Rat Carcinoma 256 and its response of X radiation (Brit. J. Cancer 4 (1950), 298).) Histologic investigation has suggested that the favourable effect of a high protein diet on the elimination of the tumour is related to the development of the well-organized capsule of connective tissue around the growing tumour. Radiation treatment, besides inhibiting division of the tumour cells, also increases the fibrosis in this capsule, which aids in the eventual elimination of the damaged tumour.

These investigations draw attention to the important rôle of tumour environment in the radiation treatment of human cancer. The results suggest that suitable regulation of nutritional conditions, such as for instance, supplying a high protein diet or supplementing the diet by protein hydrolysates etc. and by increasing protein anabolism by hormone administrations etc., may lead to improvement in clinical response.

In four pages at the end there is a clear and elegant condensation of *Advances in the study of chemical carcinogenesis* by HADDOW (Proc. Roy. Soc. Med. 44 (1951), 263). The following quotation from it shows how far we have come in cancer research. "Only very recently have be obtained our first hints as to the more precise nature of the mechanism of action of the carcinogens and the site in the cell at which it takes place. These hints have arisen in the past three years and very largely from the discovery of the carcinogenic potency of the nitrogen mustards."

F. Jacobsson.